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New Californian Spiders

RALPH V. CHAMBERLIN

The new spiders described below were found recently while identifying a collection from Claremont received from Prof. Hilton and one made by the writer in the same region in 1909 and 1913. A few forms from other localities noted in making comparisons are also included.

AVICULARIIDAE

Hexura fulva sp. nov.

Carapace and sternum with labium and endites yellow of light reddish cast, unmarked excepting for the solid black interocular area. Legs pale yellowish brown without the reddish tinge. Chelicerae typically a little darker than the carapace. Abdomen grey above and either wholly unmarked or sometimes showing a short median longitudinal pale line at base; venter paler excepting toward the spinnerets, where darkened; spinnerets pale brown like the legs. Chelicerae long, clothed above on mesal portion with long setæ which are more abundant on the anterior face below. Anterior lateral eyes much the largest, less than their long diameter apart, scarcely three times the diameter of the medians. Anterior median eyes about their radius apart, between two-thirds and three-fourths the diameter of the posterior medians, which are smaller than the posterior laterals. Tibiæ I and II armed beneath with 3-1-1 spines, the two unserried spines being at distal end. Metatarsi I and II armed beneath with 3-3 spines. Spinnerets with articles proportioned much as in *picea,* the terminal article being pointed and subannulate, but the length rather shorter than the width of the abdomen and much shorter than its length.

Length, 9 mm. Length of cephalothorax, 4 mm. Length of tib. + pat. I, 3 mm.; of tib. + pat. IV, 3.2 mm.

Type—M. C. Z. 380. Claremont.

A much lighter colored species than *picea,* the genotype, and differing in the much shorter spinnerets, in having 3-3 spines instead of 2-2 below on metatarusus I, in having the anterior lateral eyes scarcely three times instead of more than four times the diameter of an anterior median, in the proportionately broader endites, etc.

Nemesoides gen. nov.

Pars cephalica of moderate size. Fovea thoracica moderate, recurved. Anterior row of eyes procurved, median eyes much smaller than the laterals. Laterel eyes on each side less than their radius apart, the anterior scarcely larger than the posterior. Rastellum of cheliceræ well developed, the teeth long and stout. The labium broader than long, unspined. Endites armed at base with a patch of slender spines. Sternum with a pair of large impressions united at middle and in transverse line with them, near, but separated from, each lateral margin a much smaller impression. Tarsal claws with teeth numerous, in two sinuous series. Tarsi and, in part, metatarsi of first two pairs of legs scopulate. Tarsi of last two pairs of legs spined (male, genotype.) Metatarsus IV shorter than tibia IV. Superior spinnerets large, four-jointed, the distal joint short, rounded, shorter than the third and much shorter than the second. Tibia I of male with spur.

Genotype—N. hespera sp. nov.

This genus falls in Simon's group Nemesieæ in its more restricted sense.

Nemesoides hespera sp. nov.

Male—Carapace, sternum, labium and endites and legs yellowish. Cheliceræ darkened distad by the black teeth of the rastellum. Abdomen yellowish beneath; light brown above, with three longitudinal rows of short, black, transverse marks. Cheliceræ long and rather slender, extending almost directly forward, not at all geniculate, the lower teeth of rastellum stout. Anterior row of eyes procurved in such manner that the line tangent to the lower edges of the median eyes passes through or near the centers of the laterals; lateral eyes with diameter twice that of the medians; median eyes their diameter apart. Anterior and posterior lateral eyes equal or very nearly so, separated by less than half their radius. Posterior median eyes nearly of same size as the anterior medians from which separated by their radius, closer to the posterior laterals. Tibia I in male with spur or process; strongly spined; a series of long, stout spines along each side, fewer smaller ones beneath, typically a short, oblique row of four close-set and especially stout spines at the ectoventral corner of the distal end. Metatarsus I with a strong angle, or process, at middle of the ventral edge. Palpal organ as shown in pl. 1, fig. 1.

Length, 10 mm. Length of cephalothorax, 5 mm. Length of tib. + pat., 1.5 mm.; of tib. + pat. IV, 5.5 mm.

Type M. C. Z. 379. Claremont. Wm. A. Hilton coll.

DICTYNIDÆ

Amaurobius nigrellus sp. nov.

Female—Carapace dusky chestnut to nearly black. Sternum solid black. Labium and endites black or blackish excepting across tips. Legs dusky brown, the femora darker, blackish. Abdomen above and laterally blackish brown, the background black lightened by numerous minute yellowish dots; venter mesally immaculate black. Anterior median eyes their diameter apart, once and a half as far from the laterals. Posterior row of eyes but little longer than the anterior; median eyes nearly twice their diameter apart, and almost two and a half times their diameter from the laterals. Area of median eyes wider behind than in front and longer than wide. Tibia I unarmed. Anterior metatarsi well spined beneath. Tibia IV with four spines beneath, these in a longitudinal line with an extra one at distal end. Tibiæ III and IV with a small spine at the base above, in this differing from the other known North American species. Lower margin of furrow of cheliceræ armed with two teeth. Epigynum a plate subcordate in outline with a median longitudinal band extended laterad on each side behind.

Length 6 mm. Length of tib. + pat. I, 3 mm.; of tib. + pat. IV, the same.

Type—M. C. Z., 374. Cal., Claremont. Prof. Wm. A. Hilton.

Parauximus gen. nov.

Resembles Auximus in eye characters, but eyes of both rows nearly equidistant. It differs in having the lower margin of the furrow of the cheliceræ armed with eight teeth, instead of four or five, of which the most distal instead of the most proximal is largest; upper furrow with three teeth of which the median is largest. A notable feature of the genus is that the patella of the male palpus, at least in the genotype, bears a stout apophysis.

Genotype—P. tardatus sp. nov.

Parauximus tardatus sp. nov.

Male—Carapace dusky over light brown. Legs with somewhat obscure dusky annuli over yellow. Labium and endites chestnut, pale across tips. Cheliceræ dusky chestnut. Abdomen dark over sides, dorsally a pointed mark outlined in black from base to middle, followed by a series of mesally connected chevron marks. Venter immaculate light grey with an angular extension from the dark of each side just in front of the spinnerets, the two processes not meeting in the middle line. Lower margin of the furrow of the cheliceræ bearing four large teeth and proximad of these four smaller ones. Anterior median eyes very small, rather less than half the diameter of the laterals, near their diameter apart and about the same distance from the laterals. Posterior row of eyes straight; median eyes smaller than the laterals. About their diameter apart and the same distance or a little less from the laterals. Anterior laterals larger than posterior laterals and separated from them by about a radius of the latter. Tibiæ and metatarsi I and II armed beneath with three pairs of spines.

Palpus as shown in plate 1, fig. 2. Patella with a stout apophysis bearing distally numerous spines.

Type—M. C. Z. 377. Claremont.

Readily distinguishable by the characters of the eyes and the structure of the male palpus.

Auximus pallescens sp. nov.

Female—A species in appearance much resembling the preceding, though typically paler with the carapace and legs much more yellow. Sternum yellow. Labium chestnut, pale across tip, the endites lighter; also distally pale. Abdomen colored somewhat similarly to that of the preceding species, but the dorsal markings in the type indistinct. The species is easily distinguished from the preceding by its much larger anterior median eyes, which equal or nearly equal the laterals and obviously exceed the posterior medians and which are separated from each other by rather less than their radius and from the laterals by not more than once and a half their diameter. Posterior median eyes separated by near once and two-thirds their diameter and from the laterals by twice and a half their diameter, the laterals much larger. Lateral eyes on each side separated by their radius or less. Lower margin of furrow of chelicera armed with four teeth. Tibiæ I and II and metatarsi I and II each armed beneath with three pairs of spines. Epigynum, apparently not quite fully chitinized, shown in plate 1, fig. 3.

Length 12.5 mm. Length of cephalothorax, 6 mm. Length of tib.+pat. I, 5.7 mm.; of tib. + pat. IV, the same.

Type—M. C. Z. 376. Wm. A. Hilton coll.

Auximus latescens sp. nov.

Female—Carapace pale chestnut tending to testaceous in posterior and lateral regions. Legs testaceous to brown, the anterior ones often of slight chestnut cast. Sternum pale chestnut and the endites and labium darker chestnut. Chelicera dark chestnut or mahogany. The abdomen above is dark brown to blackish, with a posteriorly pointed pale mark reaching from base to middle followed by a series of pale chevron marks and on each side of it with usually three pale spots, which may be more or less connected with it or sometimes a short light line each side; venter grey-

ish brown to yellowish with two rather wide longtitudinal dark stripes which are but narrowly separated on each side from the dark of the sides. Anterior lateral eyes with diameter once and two-thirds that of the medians; median eyes about five-sixths their diameter apart, twice and a half their diameter from the laterals. Lower margin of furrow of chelicera with four teeth, of which the most proximal is largest. Tibiæ I and II armed with five spines, one at base, two sub-median and two apical. Epigynum as shown in plae 1, fig. 4.

Male—Carapace and legs somewhat paler than in the female. Eyes less widely separated. Palpal organs as represented in plate 1, fig. 5.

Type—M. C. Z. 372. Cal.: Claremont. Type taken by the author in 1909. Paratypes take in 1913. Also in 1918 coll. of Prof. Hilton.

The genus to which this and the preceding species belong, known from South America and the Atlantic Islands, has not previously been recorded from North America.

Dictyna mians sp. nov.

Female—Pars cephalica yellowish, other parts of carapace brown to fuscous. Sternum yellowish, sometimes a little dusky, with the labium similar, but endites ordinarily paler. Legs not annulate in the types though the femora may be slightly darkened and the tibia and metatarsus show vague darkening at distal end. Abdomen above yellowish, with a dark spot in front of middle from which some fine dark lines radiate and anastamose to form a network, the median longitudinal line the best developed of these; typically three pairs of widely separated dark spots on posterior portion, but these often broken or indistinct. Venter darker, sometimes a median yellow spot in front of the cribellum with one in each edge of dark area. Anterior row of eyes straight; median eyes their diameter or a little more from the laterals, farther from each other. Posterior eyes nearly equidistant. Area of median eyes wider behind than in front. Epigynum, plate 3, fig. 8.

Type—M. C. Z. 385.

Cal.: Los Angeles Co. (R. V. Chamberlin); also northern part of state (Peckham coll.).

Has resemblance to *P. calcarata*, occurring in the same localities, but easily distinguished by the structure of the epigynum and the more widely separated eyes.

SCYTODIDÆ

Plectreurys suprenans sp. nov.

Female—Differs at sight from *P. castanea* Simon, which occurs in the same region, in its much longer legs, lighter, more dilute chestnut, carapace, and the proportionately shorter and higher abdomen. The legs are brown, of less chestnut cast, with the first ones not contrasting by deeper, fuscous color. Sternum pale chestnut like the carapace. Abdomen cinereous of slight greenish cast, with pale median mark on dorsum at base. The anterior row of eyes is longer than in *castanea* with the lateral eyes comparatively smaller ,their diameter not exceeding once and a half that of the medians; median eyes about their radius apart, much farther removed from the laterals than in *castanea*, the distance being from two and a half to three times their diameter. Posterior row of eyes distinctly a little recurved instead of straight, with the median eyes larger than the laterals instead of a little smaller,

separated by their longer diameter or more, a little nearer to the laterals. The trapezium of median eyes is much wider in proportion to the length than in *castanea*. Tibia I with five to seven long, widely separated spines on ventral side, of which none are paired or, rarely, eight present with two at distal end. Spines under metatarsus I shorter, very numerous.

Male—Tibia I of palpus without apophysis at distal end. Palpus represented in plate 2, fig. 1.

Length of female, 11 mm. Length of cephalothorax, 5 mm. Length of tibia + pat. I, 6.4 mm.; of tib. + pat. IV, 4.7 mm.

Type—M. C. Z. 368. Cal.: Los Angeles, Claremont. R. V. Chamberlin coll., 1909. Wm. A. Hilton coll, 1918.

DRASSIDÆ

Drassodes celes sp. nov.

Female—Carapace and sternum with endites and labium testaceous, and legs yellow. Cheliceræ darker brown or pale chestnut. Abdomen ventrally clear yellow in front of the genital furrow excepting the dark epigynal area; behind the furrow dusky grey over a yellow background; dorsally dark olive grey due to dense clothing of hair. Upper margin of furrow of chelicera with three teeth of which the median is largest; lower margin with two small teeth. Anterior row of eyes rather strongly procurved; median eyes a little more than their diameter apart and a little more than their radius from the laterals, which are nearly their diameter from lower edge of clypeus. Posterior row of eyes scarcely procurved, much longer than the anterior row; lateral eyes smaller than the anterior laterals from which separated by once and a half the diameter of the latter; median eyes oblique, scarcely more than their long radius apart, twice their long diameter and nearly three times their lesser diameter from the smaller laterals. Tibiæ I and II armed beneath with but a single spine, which is attached a little distad of middle and toward the mesal side. Metatarsi I and II with a single spine beneath, this at base. All tarsi scopulate. Anterior metatarsi, and metatarsus III at distal end also, scopulate. Epigynum represented in pl. 2 f. 2.

Length, 10 mm. Length of cephalothorax, 4.5 mm. Length of tib. + pat. I, 4.5 mm.; of tib. + pat. IV, 5 mm.

Type—M. C. Z. 360. Cal.: Claremont. Wm. A. Hilton.

An obviously larger species than *D. robustus* which has a very different epigynum and bears no spine under tibia I. Only the male of D. *californicus* is known; but this may be distinguished from the present species by its different eye relations; e. g., in having the posterior laterals larger than the medians and the latter farther apart. It also has two pairs of spines under tibia, I which may not be a secondary character.

Scoptophaeus voluntarius sp. nov.

Female—Carapace, sternum and legs pale chestnut, the posterior legs and the coxæ beneath more brown and the anterior legs dusky or blackish beyond the femora. Endites like sternum, the labium and chelicera a darker chestnut. Abdomen blackish grey above and laterally, with a faintly indicated pale mark at base above; venter yellow in front of genital furrow and dusky greyish yellow behind it, with a pair of interrupted longitudinal dark lines. Epigynum blackish. Furrows of cheliceræ unarmed. Anterior row of eyes procurved; median eyes between one-half and three-

fourths their diameter apart, only about one-eighth their diameter from the much smaller lateral eyes and less than their diameter from the lower edge of clypeus. Posterior row of eyes a little longer than the anterior, a little procurved; median eyes their diameter or scarcely more apart, closer to the laterals. All tarsi with well developed scopulæ and the anterior metatarsi also scopulate. Tibiæ I and II each with a single spine at distal end beneath and metatarsi I and II each with one at base beneath. For form of epigynum see pl. 2, f. 3.

Length 8.5 mm. Length of cephalothorax 4 mm. Length of tib. + pat. I, 3 mm.; of tib. + pat. IV, 3, 1 mm.

Type—M. C. Z. 361.

Herpyllus pius sp. nov.

Female—This large form in general appearance resembles *H. validus*, which is common in the same region; but, aside from readily noted differences in eyes and especially in the epigynum, it may easily be distinguished in having no spines beneath on tibia I, whereas *validus* has three spines as on tibia II, which is similarly armed in the present species. Carapace and legs pale chestnut. Sternum and endites similar but the labium and cheliceræ darker. Abdomen grey, densely clothed with hair, as usual, the type not showing any definite markings. Hairs of plumose type, as usual. Posterior row of eyes considerably longer than the anterior, clearly procurved; median eyes circular, subequal to or scarcely smaller than the laterals, slightly more than their diameter apart and twice their diameter from the laterals. Anterior median eyes considerably larger than the laterals, their radius apart, closer to the laterals. Furrow of cheliceræ armed above with three small teeth, below with one. For epigynum see pl. 2, f. 4.

Length, 11 mm. Length of cephalothorax, 5 mm. Length of tibia patella I, 4.5 mm.; of tib. + pat. IV, 5 mm.

Type—M. C. Z. 365.

Cal.: Claremont. R. V. Chamberlin coll., 1909.

Zelotes taibo sp. nov.

Female—Carapace and sternum reddish yellow, the legs yellow without the reddish cast. Endites like sternum, the labium and cheliceræ darker. Abdomen grey without distinct markings. Posterior row of eyes distinctly longer than the anterior, a little procurved; median eyes elongate, elliptic, very oblique to each other, larger than the laterals, separated from each other by less than their radius, nearly their diameter from the laterals. Anterior median eyes smaller than the laterals, about their radius apart, not more than half as far from the laterals. Lateral eyes on each side separated by more than their radius but less than their diameter. Tibia I unarmed beneath, metatarsus I with a ventral spine at base. Tibia II beneath with a submedian spine, metatarsus II with a spine at base. Form of epigynum represented in pl. 2, f. 5.

Length, 6.5 mm. Length of cephalothorax, 2.9 mm. Length of tib. + pat. I, 1.4 mm.; of tib. + pat. IV, nearly the same or slightly less.

Type—M. C. Z. 367. Claremont.

Zelotes irritans sp. nov.

Male—Carapace, sternum, legs, and mouthparts dusky over a yellow background,

the anterior tibiæ more blackish than the posterior. Abdomen greyish black. Posterior row of eyes but little longer than the anterior, slightly procurved; median eyes broadly slightly obovate, much larger than the laterals, separated from each other by less than their radius, twice as far from the laterals. Anterior median eyes very much smaller than the laterals, to which they are very close, separated from each other by their diameter. Tibia I armed beneath with a single submedian spine; tibia II armed beneath with three spines, two of these being submedian and at slightly different levels and one sub-basal. Palpus as shown in pl. 2, f. 6.

Length, 5.1 mm. Length of cephalothorax, 2.25 mm. Length of tib. + pat. I, 2.1 mm.; of tib. + pat. IV, 2.5 mm.

Type M. C. Z. 366. Claremont.

Zelotes gynethus sp. nov.

Female—A dark colored species having the general appearance of *Z. niger* but readily distinguishable in its smaller and very differently formed epigynum, etc., and from other species also by that character and those of the eyes. Carapace black of slight chestnut cast, shining. Legs dusky mahogany or the proximal joints, especially of the anterior pairs, solid black. Sternum dusky chestnut, the labium and endites similar. Abdomen greyish black above, paler beneath, without markings. Posterior row of eyes very slightly procurved, considerably longer than the anterior row; median eyes nearly their diameter from the laterals and a little nearer to each other. The anterior median eyes are characteristically very small, being greatly exceeded by the laterals from which separated by not more than half their radius, separated from each other by once and a half or more their diameter. No ventral spines on tibiæ I and II or on corresponding metatarsi. For form of epigynum see pl. 3, f. 1.

Length, 8 mm. Length of cephalothorax, 3.1 mm. Length of tib. + pat. I, 2.9 mm.; of tib. + pat. IV, 3.4 mm.

Type—M. C. Z. 363. Cal.: Claremont.

Zelotes ethops sp. nov.

Male—Carapace and legs brownish yellow, the sternum clearer yellow. Labium darker than sternum, the endites like sternum. Cheliceræ brown. Abdomen grey. The species seems readily distinguishable from those described previously from North America in the atypical character of the eyes and endites. The posterior row of eyes, which is straight, not at all longer than the anterior, the eyes all being close together, the medians but slightly separated and but little farther from the somewhat smaller laterals. The anterior row of eyes procurved with the laterals but little more than their radius removed from the edge of the clypeus; the median eyes, which are much smaller than the laterals, separated by but little more than their radius and much closer to the laterals. Lateral eyes on each side much nearer to each other than the medians, separated by less than their diameter. Cheliceræ armed above with three small teeth, below with two. The endites are characterized by having the palpus inserted at or a little distad of the middle, obviously farther distad than usual. Tibia I and metatarsus I unarmed beneath; tibia II also unarmed beneath but metatarsus II with two spines in longitudinal line beneath. Anterior spinnerets large, much exceeding the posterior.

Length of not fully mature male type, 6 mm. Length of cephalothorax, 3.1 mm. Length of tib. + pat. IV, 3.4 mm.

Type M. C. Z. 362. Cal.: Claremont.

PHOLCIDÆ

Psilochorus californiæ sp. nov.

Carapace, sternum, and legs yellow or the carapace and legs proximally of pale brown cast; the femora proximally and the patellæ and tibiæ at ends often tinged with bright red. The head and the furrows commonly darker than other parts of carapace, with the eyes enclosed in black. The abdomen to the naked eye appears grey, commonly of a greenish tinge; under the lens it shows on the sides numerous light, somewhat silvery, spots and above a basal pale mark, with several pairs of dark spots enclosed by the light ones and often more or less subdivided. Posterior row of eyes straight; the median eyes nearly their diameter apart, their radius or a little more from the anterior lateral eyes, and three-fourths their diameter from the anterior medians. Anterior eyes in a strongly procurved row, with the medians much the smaller, as usual. In the male the apophysis on the chelicera is attached near the middle of the anterior face and projects directly downward or a little forward of downward; it is smaller than in *cornutus* and differs also in position and form from that in *pullulus*. (Pl. 3, f. 2.) The species is most readily recognized by the structure of the male palpus, which is represented in pl. 3, f. 3.

Length (male), 3.2 mm. Length of femur I, 4.8 mm.; of femur IV, 3.8 mm.; of tib. + pat. I, 5 mm.; of tib. + pat. IV, 4 mm.

Type—M. C. Z. 370.

Cal.: Claremont. R. V. Chamberlin coll., 1909. Also Wm. A. Hilton coll., 1918.

THERIDIIDÆ

Lithyphantes mimoides sp. nov.

Female—Carapace reddish brown or chestnut, darker on lower part of sides and with an obscure median longitudinal dorsal line on pars cephalica at least. Sternum chestnut, sometimes nearly black. Legs chestnut, with anterior tibiæ darker. Cheliceræ, labium and endites darker, almost mahogany. Abdomen in general silvery white, with a close network of fine brown lines; dorsum typically with four pairs of dark spots of which the most caudal are united; a narrow, brown hastate mark along middle, a brown stripe on anterior face and extending caudad along each side where it bifurcates, a series of oblique lines uniting the two branches in the caudal region; venter covered with a network of dark lines and spots. Anterior row of eyes nearly straight or slightly procurved. Anterior median eyes smaller than the laterals, their diameter or more apart and slightly farther from the laterals. Lateral eyes on each side narrowly separated, obviously closer to each other than in *corollatus*, equal. Posterior row of eyes slightly procurved. Posterior median eyes their diameter apart, nearly twice as far from the equal laterals. The species is easily separable from *L. corollatus*, which it superficially resembles, by the strongly different form of the epigynum as well as by the difference in eye arrangement noted above. See pl. 3, f. 4.

Length, 7.5 mm. Length of cephalothorax, 2.9 mm. Length of tib. + pat. I, 3.4 mm.; of tib. + pat. IV, 3.2 mm.

Type—M. C. Z. 340. Oregon: Portland. S. Henshaw coll., June 19, 1882.

ARGIOPIDÆ

Aranea gosogana sp. nov.

Female—This species falls in the group with longitudinal thoracic furrow, the

anterior femora armed beneath with a double series of numerous stout spines, and the abdomen broadly triangular-oval in outline (*Neoscona* in part.) In coloration it differs from *A. utahana* Chamb., e. g., in having the anterior tibiæ and metatarsi only biannulate instead of triannulate, the median annulus being absent, while the femora have an annulus only at the distal end. In the type the carapace is somewhat darkened in a median longitudinal stripe and may have been blackish in life. Thorax blackish at sides. Abdomen in general light yellowish; on posterior portion above a black line with posterior end bifurcating, and a black line on each side also running caudad from anterior end of the median line; on sides a series of brownish, parallel, subvertical lines; venter not unusually black as it is in *utahana.* The scape of the epigynum instead of curving evenly with convexity ventrad, is straight to the distal end which is bent abruptly ventrad instead of curving dorsad as in *vertebrata.* This bending may in part be an artifact as the abdomen in the type was shrunken firmly against the end of the scape. See pl. 6, f. 6.

Length, 14 mm. Length of abdomen, 11.5 mm.; width, 9.6 mm. Length of cephalothorax, 6.6 mm. Length of tib. + pat. I, 7.2 min.; of tib. + pat. IV, 6.5 mm.

Type—M. C. Z. 388. Cal.: Desert region.

THOMISIDÆ

Thanatus retentus sp. nov.

Female—Carapace with a chocolate colored band on each side above a pale marginal stripe, with a broad median dorsal pale stripe embracing typically a darker median longitudinal mark which bifurcates at the posterior border of head and is continued forward as interrupted dark lines, a median dark line also present betweeen these branches. Lower median region of clypeus pale. Sternum yellow, densely dotted over borders, or sometimes over entire surface, with minute dark spots. Legs brown, lined and mottled with black, the joints showing some clearer longitudinal lines particularly on the femora. Abdomen above yellowish with a dark colored basal sagittate mark reaching to middle or indistinctly continued beyond in an interrupted median line; on posterior region a dark area showing several chevron marks united on each side in a line or band with wavy exterior edge; typically the venter shows two narrowly separated median black lines united in an acute angle in front of spinnerets and ectad of this on each side another dark line. Posterior row of eyes strongly recurved, as usual, the median eyes scarcely nearer to each other than to the laterals (cir. 14:15). Area of median eyes narrower in front than behind, longer than wide in about ratio 20:17. Anterior medians twice as far from each other as from the laterals. Epigynum as shown in pl. 6, f. 5.

Type—M. C. Z. 389.

Claremont. A common species in this region.

This form is readily distinguishable from *coloradensis,* with which it has heretofore been confused, by the obviously different form of the epigynum.

AGELENIDÆ

Agelena rua sp. nov.

Male—Carapace with the sides dark, as usual, the median band yellow. Sternum dusky over yellow with a clear median longitudinal line. Legs light yellow, obscurely

annulate with dark. Cheliceræ pale brown. Dorsum of abdomen dark grey along sides, the median region light reddish with a series of yellow spots along each edge; sides of abdomen yellowish grey lightly spotted with black; venter limited on each side by a longitudinal dark line, the intervening region almost immaculate. Posterior eyes equidistant, not fully their diameter apart. Anterior median eyes much smaller than the laterals, near their radius apart, a little nearer to the laterals. Palpal organ represented in pl. 4, f. 1.

Length, 7 mm. Length of cephalothorax, 3.2 mm. Length of tib. + pat. I, 4.5 mm.; of tib. + pat. IV, 4.7 mm.

Type—M. C. Z. 384. California: Catalina Id.: Avalon Bay. Wm. A. Hilton coll., Aug. 25, 1918.

Distinct from other North American species especially in the structure of the male palpus.

CLUBIONIDÆ

Olios schistus sp. nov.

A species approaching *O. peninsulanus,* known from Lower California, but differing in coloration and various details of structure. While in *peninsulanus* the carapace, labium, endites, cheliceræ and legs are uniformly immaculate pale yellow, in the present species the legs are darkened by numerous minute, dark, somewhat purplish, spots which show a tendency to condense into an irregularly defined annulus at proximal end of tibiæ; similar but fewer dots occur on carapace and cheliceræ, but the sternum is immaculate. Abdomen also very obviously darker and differently marked, being densely spotted and streaked on the sides with blackish and less strongly so above and below, the dorsum with a clear sagittate mark at base, followed by a series of short chevron marks united along middle by a black line which is furcate at its anterior end. Anterior eyes obviously larger than the posteriors; anterior median eyes their diameter from the laterals and a little farther from each other, the eyes being more widely separated than in *peninsulanus.* Posterior rows of eyes a little procurved instead of straight, and the eyes much more widely separated than in the species mentioned, the medians being three times their diameter apart and as far or nearly as far from the laterals. Epigynum decidedly larger proportionately, with the outer ridges posteriorly more thickened and elevated with reference to the inner rims, etc. See pl. 4, f. 2. The palpal organ of male of similar structure but obviously heavier; the proximal apophysis of tibia larger, distally clavately expanded and truncate instead of being distally pointed with the setose edge long and oblique; the anterior apophysis also differing as shown in pl. 4, f. 3.

Length of female, 10.5 mm. Length of cephalothorax, 4.8 mm. Length of tib. + pat. I, 6.8 mm.; of tib. + pat. IV, 6 mm. A male with cephalothorax 4.8 mm. long has tib. + pat. I, 8 mm. and tib. + pat. IV, 6 mm. long.

Type—M. C. Z. 354.

Cal.: Claremont. R. V. Chamberlin coll. Also Wm. A. Hilton 1918 coll.

Anyphaena crebrispina sp. nov.

Male—Carapace and legs dull yellow, a dusky band along upper part of each side of the former. Sternum, labium and endites also yellow, the cheliceræ brown. Abdomen dull grey of slight yellow cast; dorsum with a few dark spots, the sides with more numerous dark spots and streaks; venter with some spots on posterior portion,

dusky in front of genital furrow. Armature of cheliceræ normal. Anterior row of eyes straight; eyes less than their diameter from lower margin of clypeus. Anterior median eyes obviously smaller than the laterals, rather less than their radius apart, closer to the laterals. The lateral eyes on each side their radius apart. Tibiæ I and II armed beneath with three pairs of long spines, the corresponding metatarsi with two pairs. Coxæ of third and fourth and femora of third legs densely spinulose beneath. Furrow of posterior spiracles a little behind middle of abdomen. Palpus pl. 4, f. 4.

Length, 5 mm. Length of cephalothorar, 2.5 mm. Length of tib. + pat., 2.6 mm.; of tib. + pat. IV, the same or nearly so.

Type—M. C. Z. 353. Cal.: Claremont. Pomona College coll.

Anyphæna ruens sp. nov.

Male—Carapace and legs yellowish, the legs with some obscure dusky markings. Sternum, labium and endites yellow. Abdomen yellowish grey; immaculate beneath; streaked and spotted with brown over the sides and the lateral portion of the dorsum; dorsum posteriorly with two or three rows of spots more or less confluent into chevrons, preceded by a pair of spots, the anterior median region of dorsum immaculate. Armature of cheliceræ typical. Clypeus not quite as wide as diameter of anterior eyes. Anterior row of eyes straight. Anterior median eyes a little smaller than the laterals, their radius apart, much closer to the laterals. Posterior eyes equal, obviously longer than the anterior ones, the row very slightly procurved. Posterior median eyes their diameter or slightly farther apart. The eyes in general closer together than in *incursa*, those of which they somewhat suggest. Tibiæ I and II armed beneath with two pairs of spines—one pair basal and one submedian—and metatarsi I and II similarly armed, the spines in length from about once and a half to twice the diameter of the joint. Furrow of posterior spiracle rather behind middle of abdomen. Palpus as shown in pl. 5, f. 1.

Type—M. C. Z. 352. Cal.: Claremont. R. V. Chamberlin coll.

Anyphæna zina sp. nov.

Female—Carapace yellow, somewhat darker on the sides, as usual. Legs yellow, marked with a few much interrupted and often obscure annuli, the femora beneath with a longitudinal row of black dots. Sternum, labium and endites yellow. Cheliceræ brown. Abdomen yellowish grey; minutely spotted with dark above and over the sides; venter mostly nearly free from spots, but with a dark line from epigynum to furrow of posterior spiracle. Clypeus about as wide as an anterior median eye. Anterior row of eyes a little recurved. Anterior median eyes much smaller than the laterals, not more than their radius apart and much closer to the laterals. Posterior median eyes and anterior laterals about equal in size, the posterior laterals larger. Posterior row of eyes slightly procurved. Posterior median eyes a little more than their diameter apart, a little nearer to the laterals. Lateral eyes on each side more than their radius but obviously less than their diameter apart. Tibiæ I and II armed beneath with three pairs of long spines, none of which are apical. Metatarsi I and II with two pairs of spines beneath. Furrow of posterior spiracle behind middle of abdomen. Epigynum as shown in pl. 4, f. 5.

Length, 6.5 mm. Length of cephalothorax, 2.5 mm. Length of tib. + pat. I, 2.6 mm.; of tib. + pat. IV, 2.7 mm.

Type—M C. Z. 351. Cal.: Claremont. Wm. A. Hilton coll.

Anyphæna incursa sp. nov.

Female—Carapace dull yellow, darkened over the sides. Sternum, legs, endites and labium yellow. Cheliceræ chestnut. Abdomen in general yellowish grey, with a dark stripe along each dorsolateral surface, the two stripes uniting at the spinnerets. Lower margin of furrow of chelicera bearing the usual series of seven or eight small teeth. Anterior row of eyes slightly recurved, the eyes not fully their diameter from the edge of the clypeus. Anterior median eyes only slightly smaller than the laterals, their radius or scarcely more apart and not more than half as far from the laterals. Lateral eyes on each side their radius or more apart. Posterior row of eyes procurved, longer than the first row by about twice the diameter of an eye; eyes subequal to each other and to the anterior laterals. Posterior median eyes nearly once and a half their diameter apart and about their diameter from the laterals. Tibia I armed beneath with two pairs of long slender spines, one pair being basal and one median. Metatarsus with one pair of spines beneath, these basal. Tibia II armed beneath with two unpaired spines corresponding to the posterior members of the pairs present on I. Metatarsus II with a pair of spines at base beneath. Posterior spiracle in front of middle of abdomen. Epigynum as shown in pl. 5, f. 2.

Length, 6.6 mm. Length of cephalothorax, 2.8 mm. Length of tib. + pat. I, 3.2 mm.; of tib. + pat. IV, 2.9 mm.

Type—M. C. Z. 350. Claremont. Pomona College Coll.

Anyphæna mundella sp. nov.

Female—Carapace yellow of pale brownish cast, a little darkened on the sides. Sternum yellow. Legs of same color as carapace. Abdomen above grey marked with numerous distinct dark dots, which show a tendency to be arranged in transverse series; venter paler, almost immaculate, reddish in front of genital furrow, the epipynum dark. Lower margin of furrow of chelicaræ armed with a series of seven or eight small teeth which decrease in size proximad. Anterior row of eyes straight, each removed by more than its radius but less than its diameter from lower margin of clypeus. Anterior median eyes only very slightly smaller than the laterals, their radius or but little more apart but only slightly separated from the lateral on each side. Lateral eyes on each side about their radius apart. Posterior row procurved; eyes very nearly equal in size to the anterior laterals, subequal to each other or the medians scarcely smaller. Posterior median eyes once and a half their diameter apart, very nearly their diameter from the laterals. Tibiæ I and II and also metatarsi I and II each armed beneath with two pairs of long spines. Furrow of posterior spiracle at middle or slightly behind middle of abdomen. Epigynum as shown in pl. 5, f. 3.

Male—Palpal organ as shown in pl. 5 f. 4.

Length of female, 6.8 mm. Length of cephalothorax, 2.9 mm. Length of tib. + pat. I, 4 mm.; of tib. + pat. IV, 3 mm.

Type—M. C. Z. 348.

Cal.: Claremont. R. V. Chamberlin coll. Also Wm. A. Hilton coll., 1918.

Anachemmis gen. nov.

Cephalothorax similar in form to that of Chemmis. Anterior row of eyes nearly straight or a little recurved. Anterior median eyes smaller than the laterals. Posterior row of eyes much longer than the anterior row with eyes larger, the medians notably

exceeding the anterior medians, the row typically a little recurved. Area of median eyes narrower in front than behind where the width almost equals the length. Clypeus narrow, not exceeding the anterior eyes. Later eyes contiguous. Labium, endites and sternum essentially as in Chemmis, but the lower margin of the furrow of cheliceræ armed with three teeth instead of two. The anterior tibiae bear similarly five pairs of long spines beneath; but the metatarsi bear three pairs instead of two. The posterior tibiae bear two median dorsal spines instead of wholly lacking these as in Chemmis.

Genotype.—A. sober sp. nov.

This genus appears also to include *Chemmis unicolor* of Banks from Arizona in addition to the two species here described. These species are more uniformly colored than the species of Chemmis; and, in having all markings nearly obliterated, contrast conspicuously in general appearance with the members of that genus.

Anachemmis sober sp. nov.

Female—Carapace dusky over a brown to light chestnut ground. Legs light brown to light chestnut, without markings. Sternum light brown or testaceous. Labium and endites darker, pale across distal ends. Cheliceræ chestnut. Abdomen dusky brown or blackish, with a median dorsal light line at base extending to near middle, a light spot on each side opposite each end and two or three pairs of light spots farther caudad, but these light marks commonly vague; venter paler, showing a yellowish background darkened by dark psots. Anterior row of eyes nearly straight; the median eyes much smaller than the laterals and especially than the posterior medians, their diameter apart and about half as far from the laterals. Posterior row of eyes a little recurved, eyes subequal; posterior median eyes about their diameter or a little more from the laterals, three-fourths or less their diameter apart. Epigynum as shown in pl. 5, f. 5.

Length up to 10.5 mm. Length of cephalothorax, 4.5 mm. Length of tib. + pat. I, 5 mm.; of tib. + pat. IV, the same.

Cal.: Claremont. R. V. Chamberlin. Paratypes from same region also in collection received from Prof. Hilton.

Anachemmis dolichopus sp. nov.

Female—Contrasts in general appearance with the preceding species in its very long legs and much lighter color. The carapace, sternum and legs are yellowish brown without markings, but the legs are somewhat darkened over tibiæ and distal joints. The abdomen is uniform grey throughout, with no definite markings. The anterior row of eyes slightly recurved; median eyes much smaller than the laterals, about their diameter apart, closer to the laterals. Posterior row of eyes straight; medians smaller than the laterals, about their diameter apart, nearly half as far again from the laterals. Legs very long. Readily distinguishable by the form of the epigynum as shown in pl. 5, f. 6.

Male—Palpus shown in pl. 5, f. 7.

Length of female, 10 mm. Length of cephalothorax, 4.5 mm. Length of leg I, exclusive of coxæ, 17 mm.; of tib. + pat. I, 6.5 mm.; of tib. + pat. IV, the same.

Type—M. C. Z. 344. Cal.: Claremont. Wm. A. Hilton coll.

Namopsilus gen. nov.

Cephalothorax with general form much as in Trachelas. Sternum broadly truncate anteriorly, pointed at caudal end, margined. Endites not excavated exteriorly, as broad at middle as at distal end; the distoectal corner rounded. Labium distally truncate or a little incurved. Lateral eyes on each side well separated, though much closer together than the anterior and posterior medians. Anterior row of eyes straight. Anterior medians smaller than the laterals. Posterior row of eyes slightly recurved, eyes equidistant or nearly so and nearly equal in size, with the laterals equal to the posterior laterals. Quadrangle of median eyes wider behind than in front. Clypeus much wider than the anterior eyes. Upper margin of furrow of chelicera with three large teeth, of which the median is longest; lower margin with a series of seven or eight teeth, of which the most proximal ones become reduced in size. None of the legs scopulate and all lacking terminal tenent hairs. Anterior tibiæ armed beneath with four pairs of long spines, the metatarsi with three pairs. Posterior tibiæ in middorsal line with a basal and a subapical spine, and each patella with a median spine at distal end above, these dorsal spines smaller than the laterals and ventrals.

Genotype.—*N. pletus* sp. nov.

Namopsilus pletus sp. nov.

Female—Carapace chestnut colored, dusky over the sides, eye region, along striæ and over clypeus. Legs light chestnut-brown; femora marked with two wide dark annuli, one at distal end and one submedian, these more or less interrupted above; patella with annulus about distal half also interrupted above; tibiæ with two broad annuli, one at distal end and one between middle and base, these sometimes almost confluent; entire metatarsi dusky or obscurely biannulate. Sternum light chestnut, the coxæ of legs lighter brown. Cheliceræ dusky chsetnut. Labium and endites pale across tips, elsewher edark chestnut. Sides of abdomen deep brown or blackish, the dorsum with a series of dark chevron marks ending in the dark of the sides and connected along the middorsal line, the spaces between them on each side yellowish; venter grey. Clypeus twice as high as the diameter of an anterior lateral eye. Anterior median eyes much smaller than the laterals, about their diameter from each lateral eye and considerably farther from each other. Lateral eyes on each side about their radius apart. Posterior row of eyes a little recurved. Posterior median eyes scarcely smaller than the laterals, nearly once and a half their diameter apart and an equal distance from the laterals. Epigynum as shown in pl. 6 f. 1. The spermathecæ, which ordinarily show through the integument as black bodies, are not represented in the figure.

Length, 6.5 mm. Length of cephalothorax, 4 mm. Length of tib. + pat. I, 4 mm.; of tib. + pat. IV, 3.7 mm.

Type—M. C. Z. 346. Cal.: Claremont (R. V. Chamberlin coll.; also Pomona College coll.).

LYCOSIDÆ

Lycosa ferriculosa sp. nov.

Carapace brown, paler in a supramarginal line on each side, below which the marginal dark band is interrupted, and in a median longitudinal stripe which narrows forward and projects in a point between the eyes and again expands between the first and second rows; a curved line each side of the median stripe just caudad of the eyes.

Legs testaceous, without markings excepting tibia IV, which is banded at each end with black, and metatarsus IV, which is darkened at the extreme tip. Sternum, coxæ and abdomen beneath solid black. Labium and endites black, pale across tip. Cheliceræ brown to bright chestnut. Abdomen above testaceous to yellow with a dark spear-shaped outline over basal part and ending on a chevron mark behind middle, this followed by a few other chevrons; a number of oblique lines extending out from basal mark on each side. A black band across each anterolateral corner and extending along the side where it breaks into streaks and spot; light areas of abdomen clothed with yellow hair. Upper margin of furrow of cheliceræ armed with three teeth; the lower margin also with three teeth with are stout and subequal. Anterior row of eyes much shorter than the second, distintly procurved, median eyes their radius or slightly less apart, an equal distance from the lateral eyes which are decidedly smaller, Lateral eyes scarcely their diameter from lower margin of clypeus, an equal distance from eyes of second row. Eyes of second row less than their diameter apart. Quadrangle of posterior eyes comparatively long, the cephalothorax being less than three and a half times as long.

Spines beneath tibiæ long and distally very fine. Epigynum small, of form shown in pl. 6, f. 2.

Length, 16.5 mm. Length of cephalothorax, 8 mm. Length of tib. + pat. I, 6.6 mm.; of tib. + pat. IV, 7.5 mm. A male with cephalothorax 8 mm. long has tib. + pat. I, 8 mm. and tib. + pat. IV, 8.5 mm. long.

Cal.: Claremont. R. V. Chambrelin coll.

This species suggests *L. concolor* Banks of Lower California. It is a smaller species distinguishable in having tib. + pat. IV shorter than the cephalothorax instead of clearly longer; in having a black band at both ends of tib. IV instead of only at one end; in not having the femora, metatarsi and tarsi black beneath, etc.

Pardosa tuoba sp. nov.

Female—In the types the body is dark throughout, in life clothed with grey hair; the median dorsal stripe of carapace obscure. Legs black excepting tarsi and metatarsi, which are dull brown, the latter with three black annuli; sometimes the proximal joints also show the paler color in spots and streaks or in part may be somewhat annulate. Sternum solid black. Abdomen with integument black above excepting an obscure pale mark at base; also black laterally, but the venter paler though with a deep black band between epigynum and spinnerets; venter in life clothed densely with grey hairs, the dorsum with grey and reddish intermixed with some black. Anterior row of eyes slightly procurved, much shorter than the second row; median eyes their diameter apart, not fully half as far from the four-fifths as large laterals; the latter twice their diameter from the edge of the clypeus and decidedly more than their diameter from the eyes of second row. Eyes of second row fully their diameter, or slightly more, apart. Two first pairs of spines of anterior tibiæ and metatarsi long, slender, overlapping as usual. Armature of cheliceræ typical. Epigynum of the *sternalis* type, but with the expanded quadrate posterior end of septum completely filling the posterior cavity, or nearly so, as shown in pl. 6, f. 3.

Length, 6 mm. Length of cephalothorax, 3 mm. Length of tib. + pat. I, 2.8 mm.; of tib. + pat. IV, 3 mm.

Type—M. C. Z. 356. Claremont.

Pardosa hesperella sp. nov.

Female—Carapace with broad side stripes and narrower supramarginal stripes of chocolate-brown color, the marginal lines black, the eye region also dark; middorsal yellow stripe widest just caudad of eyes with anterior margin straight, from there narrowing caudad, divided anteriorly by a fine median longitudinal black line, the stripe only obscurely indicated between eyes. Sternum black. Legs with femora longitudinally streaked above with black, the joints not annulate or only in part very vaguely so. Abdomen with a yellow basal mark above, this narrow and widening caudad; this mark is edged with black and is followed behind by several black chevron lines; venter light, with no dark markings. Anterior row of eyes straight or nearly so, median eyes their diameter or a little mor eapart, about half as far from the laterals. Eyes of second row once and a half or more their diameter apart. The epigynum seems clearly distinctive in form. See pl. 6, f. 4.

Length, 7 mm. Length of cephalothorax, 3.5 mm. Length of tib. + pat. I, 3.2 mm.; of tib. + pat. IV, 3.5 mm.

Type—M. C. Z. 392.

Montana: W. M. Mann, collector.

PLATE 1

Fig. 1. Left male palpus, ectal view, of *Nemesoides hespera,* sp. nov.
Fig. 2. Left male palpus, ectal view, of *Parauximus tardatus* sp. nov.
Fig. 3. Epigynum, not fully adult, of *Auximus pallescens* sp. nov.
Fig. 4. Epigynum of *Auximus latescens* sp. nov.
Fig. 5. Palpus of *Auximus latescens* sp. nov.

PLATE 2

Fig. 1. Left male palpus, ectal view, of *Plectreurys suprenans* sp. nov.
Fig. 2. Epigynum of *Drassodes celes* sp. nov.
Fig. 3. Epigynum of *Scotophaeus voluntarius* sp. nov.
Fig. 4. Epigynum of *Herpyllus pius* sp. nov.
Fig. 5. Epigynum of *Zelotes taibo* sp. nov.
Fig. 6. Left male palpus, ectal view, of *Zelotes irritans* sp. nov.

PLATE 3

Fig. 1. Epigynum of *Zelotes gynethus* sp. nov.
Fig. 2. Chelicera, ectal view, of *Psilochorus californiæ* sp. nov.
Fig. 3. Left male palpus, ectal view, of the same.
Fig. 4. Epigynum of *Lithyphantes mimoides* sp nov.
Fig. 5. Epigynum of *Teutana grossa* (C. Koch), a species not uncommon at Claremont.
Fig. 6. Epigynum of *Agelena pacifica,* var. Claremont.
Fig. 7. Eqigynum of *Agelena californica,* var. Claremont.
Fig. 8. Epigynum of *Dictyna mians* sp. nov.

PLATE 4

Fig. 1. Left male palpus, ectal view, of *Agelena rua* sp. nov.
Fig. 2. Epigynum of *Olios schistus* sp. nov.
Fig. 3. Left male palpus, ectal view, of *Olios schistus* sp. nov.
Fig. 4. Male palpus, left ectal view, of *Anyphæna crebrispina* sp. nov.
Fig. 5. Epigynum of *Anyphæna zina* sp. nov.

PLATE 5

Fig. 1. Right male palpus, ectal view, of *Anyphæna ruens* sp. nov.
Fig. 2. Epigynum of *Anyphæna incursa* sp. nov.
Fig. 3. Epigynum of *Anyphæna mundella* sp. nov.
Fig. 4. Left male palpus, ectal view, of the same.
Fig. 5. Epigynum of *Anachemmis sober* sp. nov.
Fig. 6. Epigynum of *Anachemmis dolichopus* sp. nov.
Fig. 7. Right male palpus of the same.

PLATE 6

Fig. 1. Epigynum of *Namopsilus pletus* sp. nov.
Fig. 2. Epigynum of *Lycosa ferriculosa* sp. nov.
Fig. 3. Epigynum of *Pardosa tuoba* sp. nov.
Fig. 4. Epigynum of *Pardosa hesperella* sp. nov.
Fig. 5. Epigynum of *Thanatus retentus* sp. nov.
Fig. 6. Epigynum of *Aranea gosogana* sp. nov.

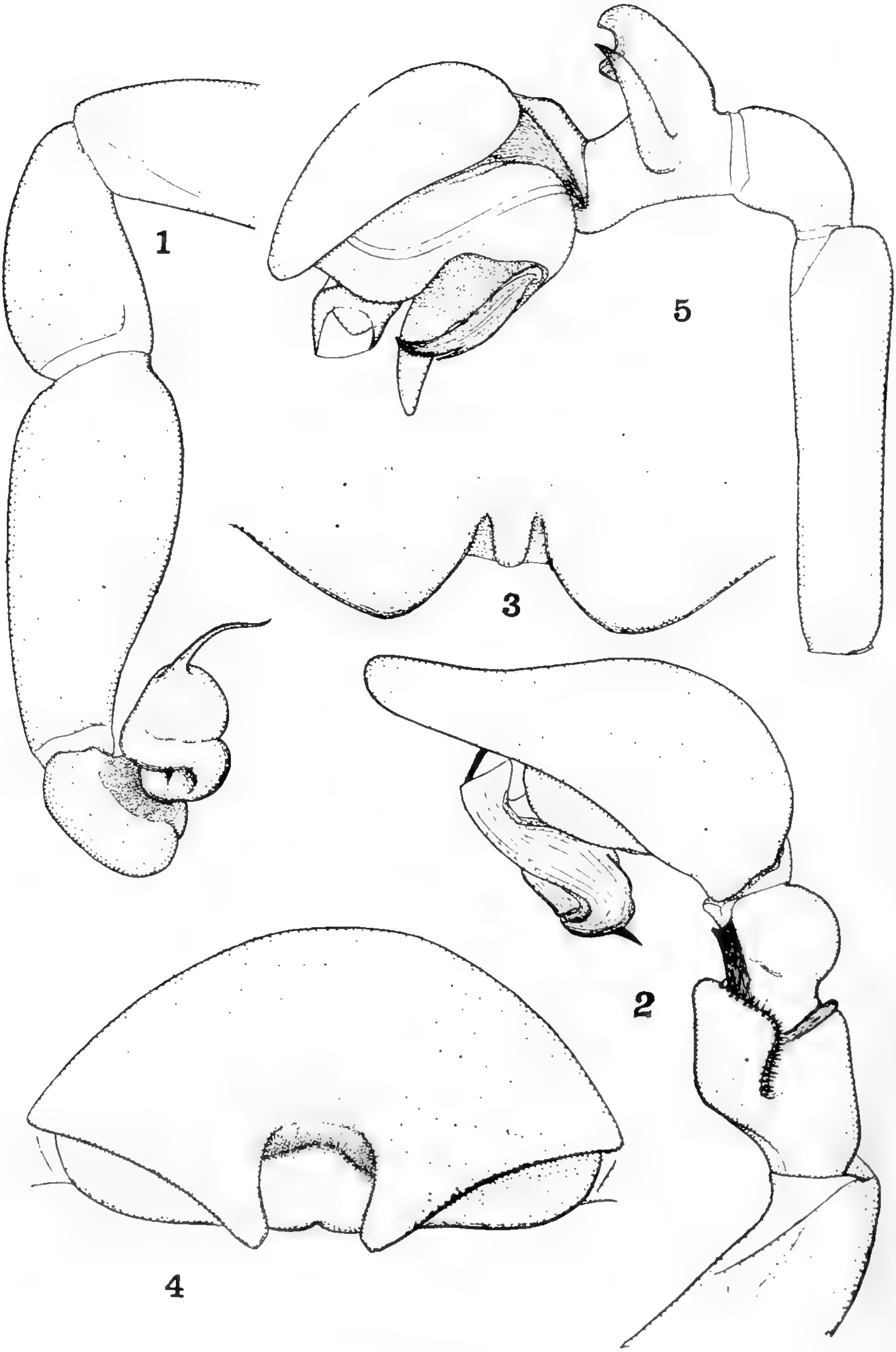
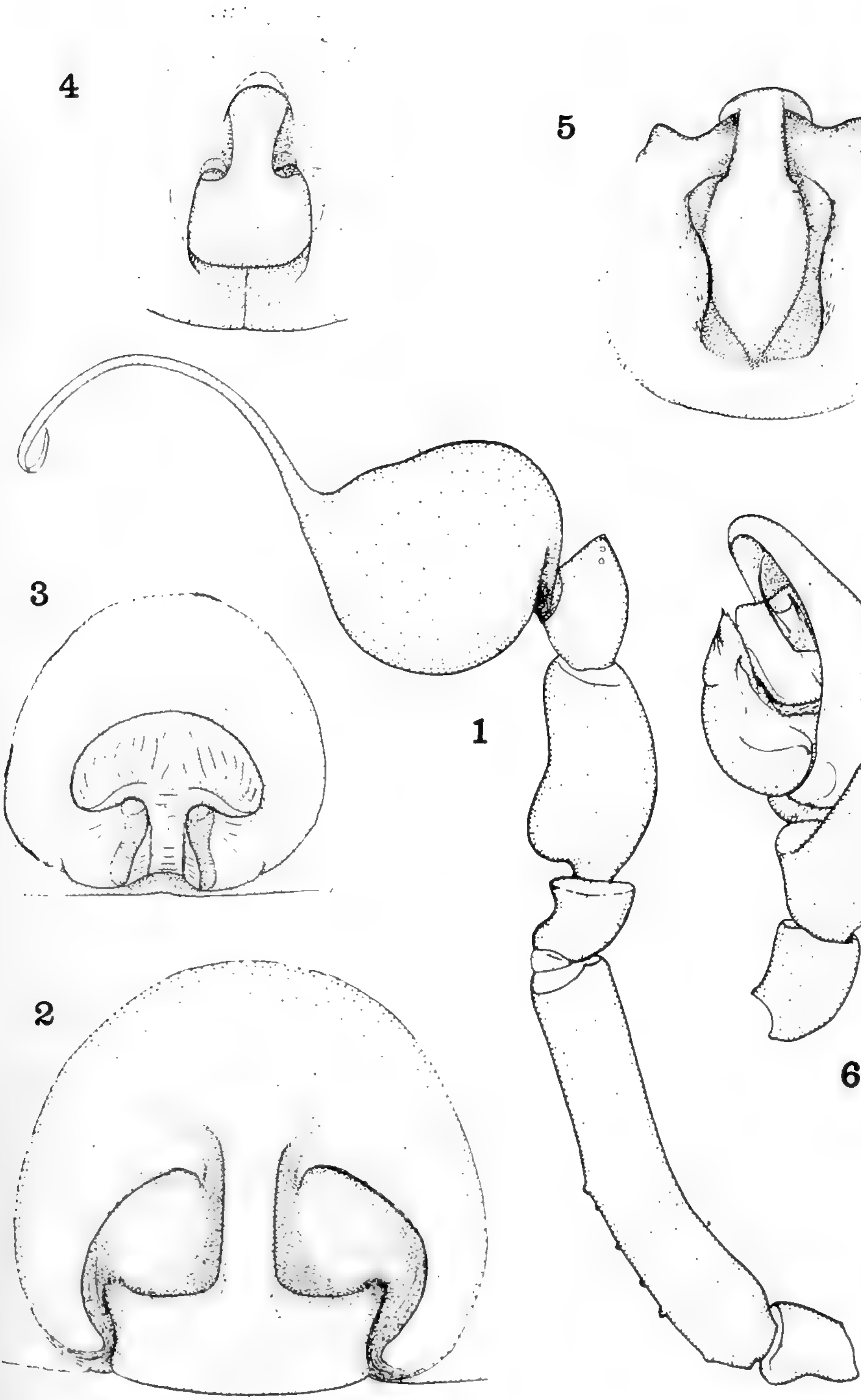


PLATE I



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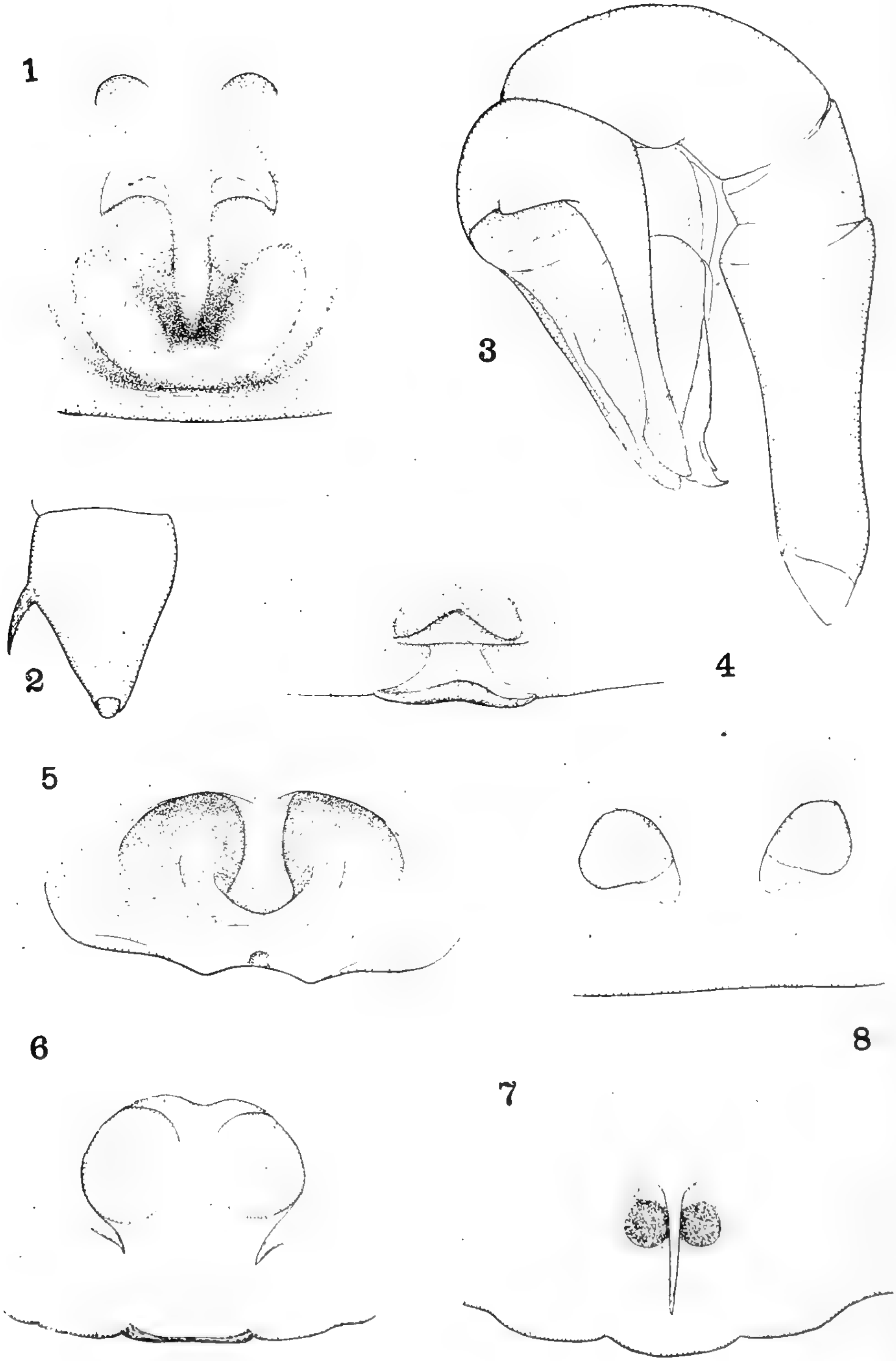

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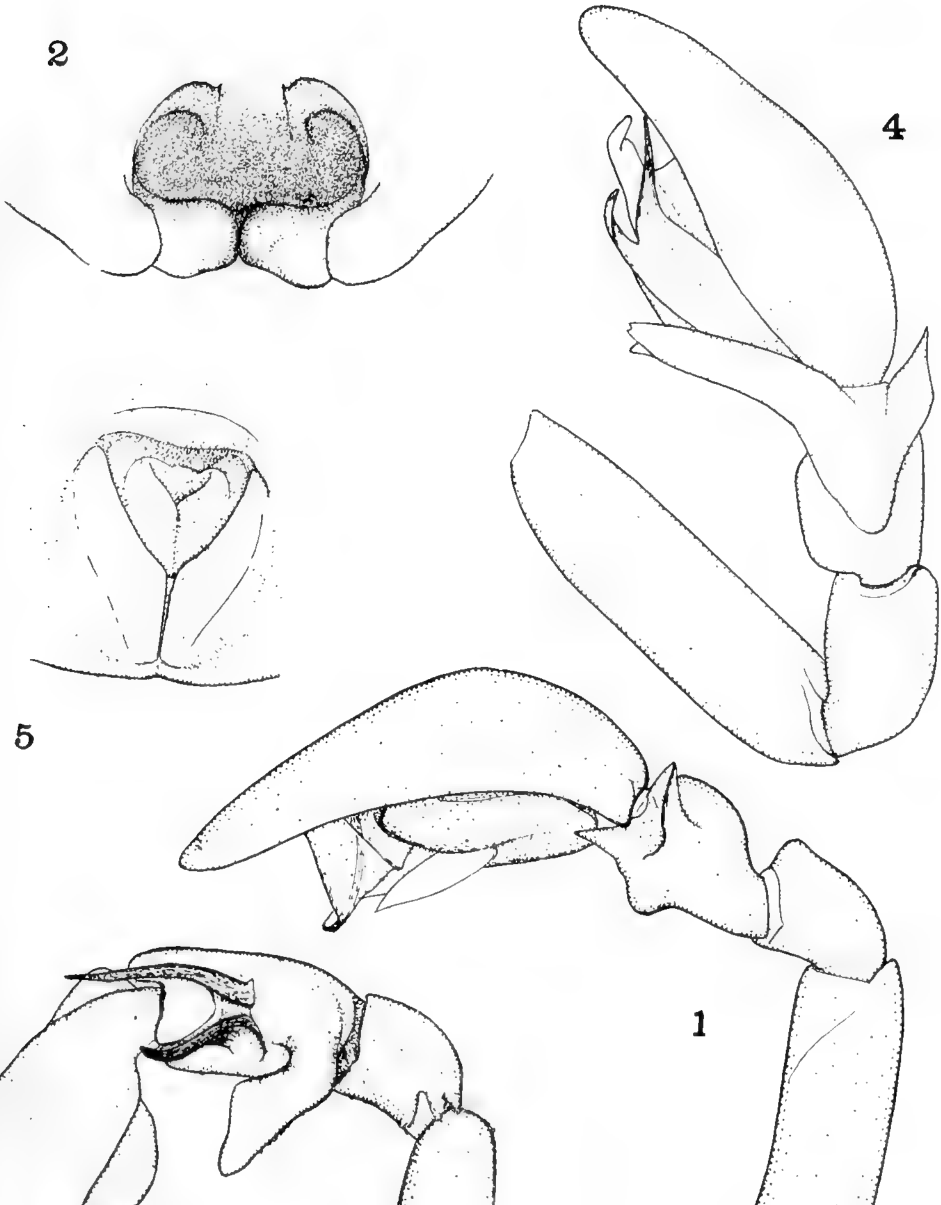

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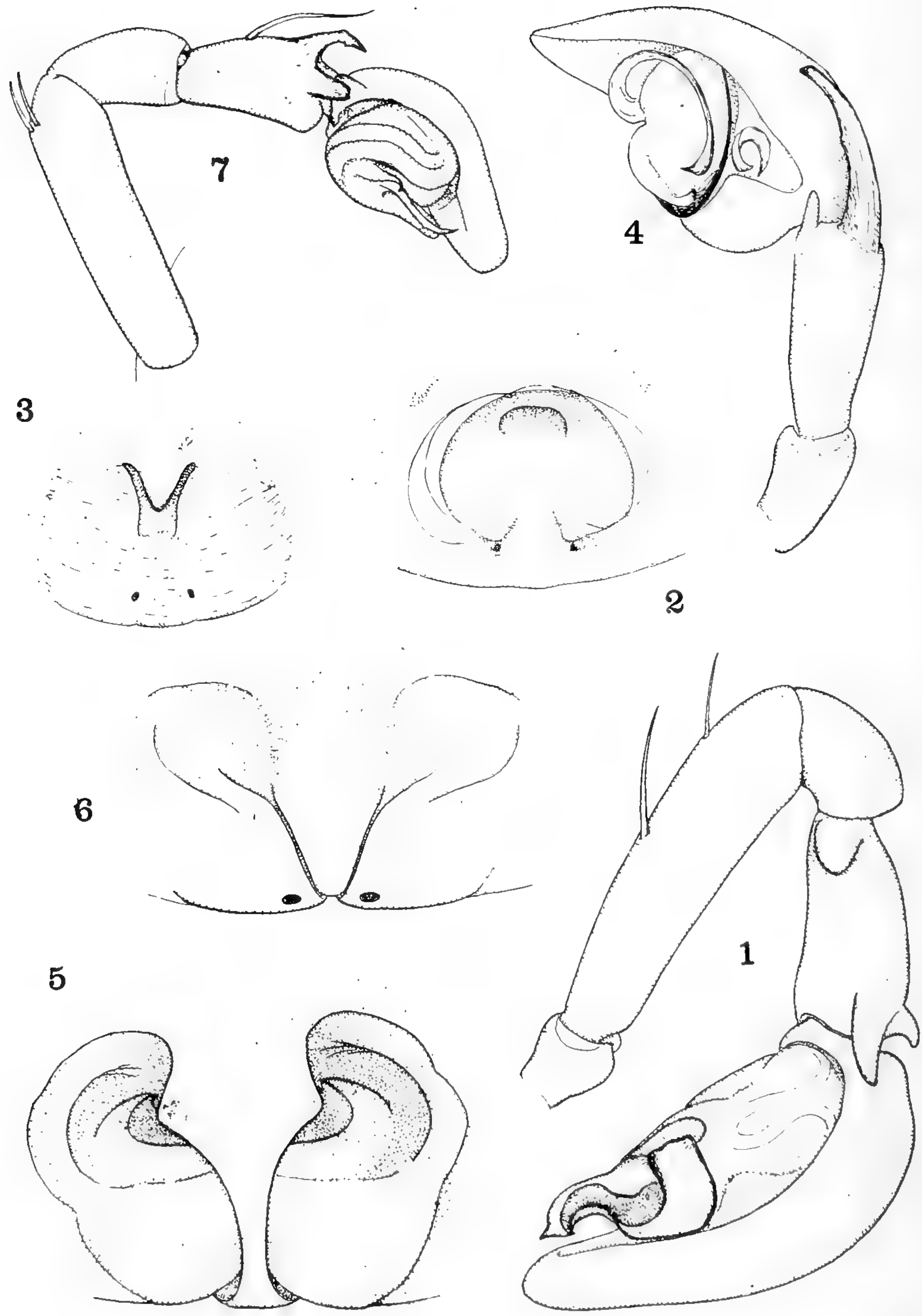


PLATE V

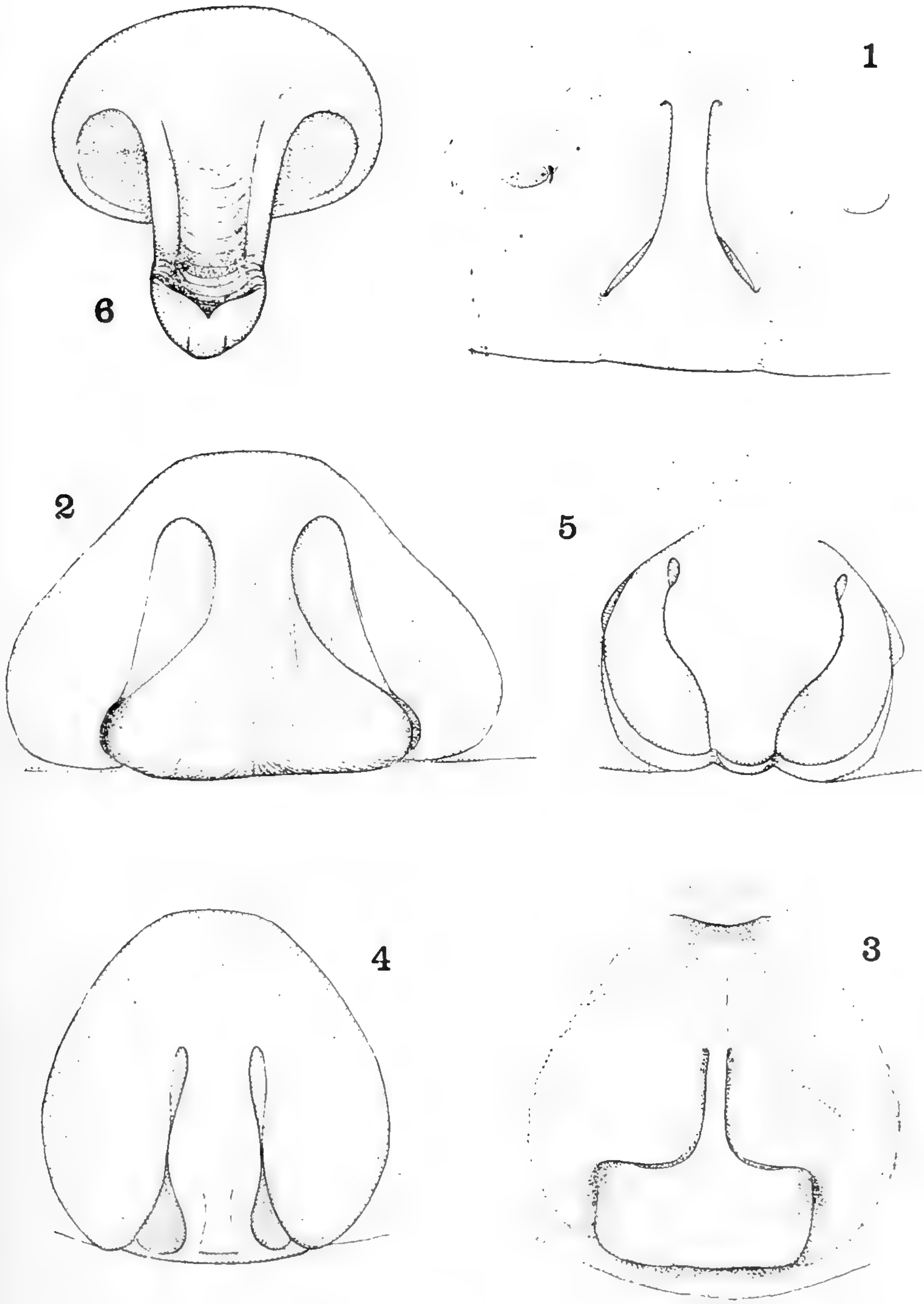


PLATE VI

Centipedes and Millepedes from Near Claremont

Most of the specimens were collected during the past few years. All but the Scutigera were determined by Dr. R. V. Chamberlin.

CENTIPEDES

Scolopendromorpha

Scolopendra polymorpha Wood. The largest local form and one of the most common.

Otocryptops gracilis (Wood). A smaller form which is also common.

Geophilomorpha

Clinopodes limatus (Wood). A species more commonly listed under Mecistocephalus sens. lat.

Nyctunguis heathi catalinæ (Chamb.)

Linotænia lævipes (Wood). This bright red species is found especially in the mountains.

Geophilus rubens Say.

Geophilus regnans Chamb. Very common.

Arenophilus bipuncticeps (Wood).

Taiyuna occidentalis (Meinert).

T. claremontus Chamb.

Tabiphilus rex Chamb.

Notobius tæniopsis (Wood). A long species with 129 to 149 pairs of legs.

Gosiphilus bakeri Chamb.

Gosphilus laticeps (Wood).

Sc. tigeromorpha

Scutigera forceps Raf. From houses.

Lithobiomorpha

Lamyctes pinampus Chamb.

Ethopolys xanti (Wood).

Gosibius paucidens (Wood). Common.

Arebius elysianus Chamb.

Nothembius nampus Chamb.

Pokabius clavigerens Chamb.

MILLEPEDES

The species described by Chamberlin were described in the Proceedings of the Biological Society of Washnigton in December, 1918, Vol. 31, pp. 165-170.

Parajulus furcifer Hag.

Tylobolus claremontus Chamb.

Hiltonius puluchrus Chamb.

Atopetholus californicus Chamb.

A. parvus Chamb.

Spiders from the Claremont-Laguna Region

The following is a list of spiders collected during the past few years. All the determinations were made for us by Dr. R. V. Chamberlin. None of the new species recently described by Chamberlin are included in this list.

AVICULARIIDÆ
Bothriocyrtum californicum (Camb.)

ULBORIDÆ
Uloborus californicus Bks. Uplands, 1200 ft. Nicholson.

DICTYNIDÆ
Dictyna calcarata Bks.

SCYTODIDÆ
Plectreurys castanea Sim.

DRASSIDÆ
Zelotes maculata Bks.
Herpyllus validus Bks.
H. angustus Bks.

PHOLCIDÆ
Physocyclus globosus Tac. Uplands Nicolson.
Pholcus phalangioides Fuessl.

AGELENIDÆ
Agelena pacifica Bks.
A. californica Bks. Claremont and interior of Catalina.
A. nævia Hentz. Claremont and Avalon, Catalina.
Tegenaria domestica Clerck.
T. californica Bks.
Chorizomma californica Simon.

LINYPHIIDÆ
Linphia Sp.

ARGIOPIDÆ
Cyclosa conica Pallas. Cucamonga Mt. 4500 to 5500 ft. Johnston.
Aranea miniata Walck.
A. curcurbitina Clerck.
A. marmorea Clerck.
A. angulata Clerck.
Metargiope trifasciata Forsk.
Zilla X-notata Clerck.
Tetragnatha laboriosa Hentz.

THERIDIIDÆ
Teutana grossa C. Koch.
Latrodectus mactans Fabr.
Theridion tepidariorum Koch.

THOMISIDÆ
Thanatus coloradensis Keys.
Xysticus californicus Keys.
X. ferox Hentz.
Misumena vatia Clerck.
Misumenoides aleatorius Hentz.
Misumenops asperatus Hentz.
Philodromus pernix Black.
P. moestus Bks.

CLUBIONIDÆ
Chiracanthium inclusum Hentz.
Trachelas tranquilla Hentz. Claremont and Catalina.
Castianeira pacifica Bks.
Gayenna Juv.

Anyphoena Juv.

LYCOSIDÆ

Lycosa kochii Keys. Claremont and Ontario Mt. 6000 to 7000 feet.

Lycosa, near *carolinensis*, not quite mature.

Pardosa sternalis Thorell.

P. lapidicina Em.

P. californica Keys.

Pardosa sp. Catalina interior. Claremont.

Central Nervous System of Mytilus Californianus

WILLIAM A. HILTON

The cerebral ganglia are well separated from each other, but the smallest of the three groups of ganglia in the nervous system. A large cephalic branch goes to the palps, smaller lateral ones supply adjacent parts in the mouth region. No attempt was made at this time to follow peripheral branches very far.

The single mass of the pedal ganglion may be easily seen to be composed of a right and a left half. The pedal connections with the main trunk are somewhat smaller than the long connectives and hardly larger than some of the other branches of the ganglion, notably the large lateral caudal branches. The caudal branches of the pedal are chiefly three on each side, the more lateral being very large and the medial the smallest. They penetrate and supply the foot and viscera.

The visceral ganglia are more widely separated than the cerebral and much larger. The large caudal branches pass over the posetrior adductor muscles to become supplied to the muscle and to the mantle. The smaller lateral branch runs out laterally dividing soon into two to supply the gills.

In the cerebral ganglion the fibers form a broad connection across the middle line. There are a few cells along the course of the commissure. Nerve cells are found inclosing the central fibrous mass. The cells are three or four layers thick except at certain places where there are none. The cells are of several sorts: First—those that stain deeply with hematoxylin. Some of these may be neuroglia cells, they are rather small cells and some seem to have very little cell body; second—large cells with clear protoplasm with distinct fibrillar structure. The processes of these are long, in some cases may be followed for some distance; third—there are some very small cells that do not stain deeply. These may some of them be neuroglia cells, others may be nerve cells in some special physiological condition.

In the fibrous areas of the ganglia, larger and smaller strands are evident, with only a few cells in central portions.

The cell areas about the cerebral ganglion differs slightly at various points, but there is no marked massing into groups.

The pedal ganglion, like the cerebral, has a central fibrous core covered with a rather even mass of cells of large and small size, but the cephalic and caudal regions have the thicker masses of cells. The ventral sides of the pedal has more cells than the dorsal. Two sides of the ganglion are well marked from each other, although broadly connected by fibers.

The large visceral ganglia are more complicated in structure than the others, but a similar general arrangement of cells is found.

The peripheral distribution of nerves was not followed at this time. For the general anatomy of bivalves one of the most recent works gives a detailed account of peripheral distribution in a bivalve:

Splittstosser, P., 1913.

Zur Morphologie des Nervensystems von Anodonta cellensis Schrot. Zeit. f. wiss. zool. Bd. CIV 3 heft.

(Contribution from the Zoological Laboratory of Pomona College.)

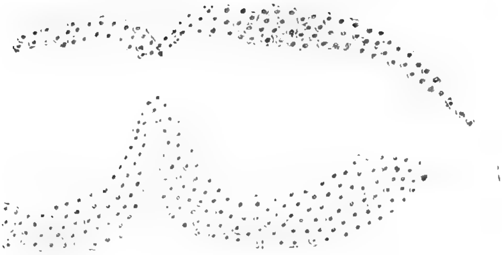
Explanation of Figures

Fig. 1. Central ganglia of Mytilus. The cerebral ganglia are above in the figure. X6.

Fig. 2. Longitudinal section of the cerebral ganglion of Mytilus. The connective end is down. X70.

Fig. 3. Cross section of the cerebral ganglion of Mytilus. The dorsal side is up. X70.

Fig. 4. Cross section of the pedal ganglion of Mytilus. The dorsal side is up. X70.



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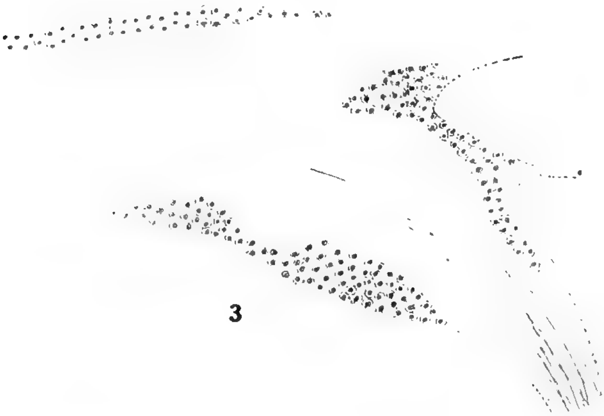

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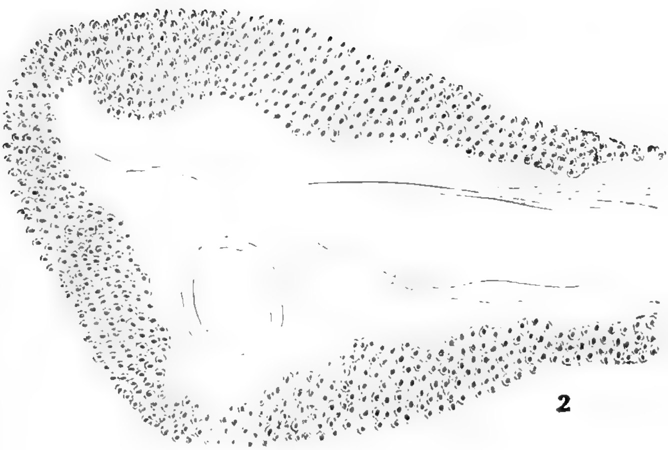

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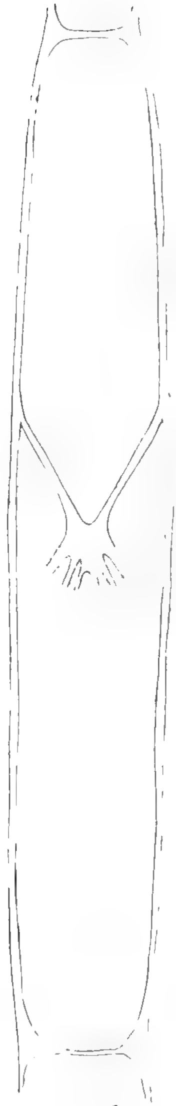

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Notes on the Sipunculida of Laguna Beach

RALPH V. CHAMBERLIN

The following notes and provisional diagnoses are based upon a collection of Sipunculids made by Prof. Hilton at Laguna Beach in 1917. Six species are represented.

SIPUNCULUS NUDUS LINN.

One specimen of this widespread species was taken on the sand flats at low tide in August, Balboa. As preserved it is 26 cms. long. Attachments of nephridia and retractor muscles normal. The usual 31-32 longitudinal muscle bands. The body appears to be pigmented to some extent, as has also been recorded for a specimen from the Malacca region described as dark brown (Selenka), and one from Key West (Gerould). The species is known from various parts of the Atlantic along both shores, from the Mediterranean, Adriatic and Red seas, Malacca, Bismarck Archipelago, Philippines and Japan.

PHYSCOSOMA AGASSIZII (KEFERSTEIN)

In the collection are six specimens of this well-marked species taken at low tide on sand flats at Balboa and Laguna Beach. The species is otherwise known to occur along the California coast (e. g., at Monterey Bay, Mendocino, San Francisco, Crescent City) and northward (Vancouver Id.) as well as southward (Puntarena, Panama). It has also been taken at Loyalty Is., Ceylon, Laccadives and Maldives, and in the Atlantic on the coasts of the United States and Africa.

DENDROSTOMA ZOSTERICOLA SP. NOV.

This species belongs to the group with but two retractor muscles. These have their origins in the posterior third of the body (in the type about 10 mm. from caudal end) and are well developed throughout and free to near insertions. The nephridia open at the level of the anus and are elongate and free. Contractile tube with numerous caeca. Tentacles strongly dendritic or arborescent, the terminal branches numerous. Introvert wholly lacking hooks. Skin brown or in part grey, set off into numerous areas, these transversely elongate in middle region, in the posterior more rectangular and longitudinally elongate. Entire body and introvert, excepting a short area proximad of tentacles, bearing moderately numerous, small, dark and rounded elevations which do not rise into true papillae; usually one of these to each cuticular area; of uniform size and abundance throughout. Body typically narrowed at both ends, fusiform. 35 mm. long behind anus and about 15 mm. to distal end of introvert.

Taken in eel-grass in September, 1917.

Type—M. C. Z. 2, 181.

DENDROSTOMA MYTHECA SP. NOV.

The type of this species was found in eel-grass (Zostera) in the same original lot with the types of the preceding species. It is a smaller species of obviously different form. The body is widest at the posterior end, followed by a much longer, narrower,

subcylindrical portion extending to the still narrower introvert proper. The species is like *zostericola* in lacking hooks on the introvert, but differs obviously in the character and arrangement of the tubercles. These are similarly small over the general body but are more closely arranged over the middle region than over the broader posterior one, while particularly characteristic is a band of abruptly much larger tubercles about the base of the introvert, distad of which region they become again abruptly smaller. The color is brown. The two retractors are inserted at the anterior end of the broad posterior region and are fused anteriorly, their free portions short. Nephridia free.

Length of body behind anus, 12 mm.; in front of this to base of tentacles, near 8 mm.

Type—M. C. Z. 2, 184.

DENDROSTOMA PYROIDES SP. NOV.

Differing conspicuously from *zostericola* in form, being broadest at the posterior end and as a whole subpyriform instead of conspicuously fusiform. It is darker brown in color. A conspicuous external difference is in having the introvert, or proboscis, armed on its median portion with numerous, comparatively large, dark hooks, which are not definitely seriate. The cuticle in general is covered with numerous small, dark, rounded elevations which in surface view are circular to slightly elliptic in outline and are larger in size at the base of the proboscis and at the posterior end of the body than elsewhere. Tentacles arborescently branched, the terminal branches numerous, finger-like. The two retractors are stout bands taking their origin in the posterior third of the body. Contractile tube with fewer caeca. Nephridia free, opening a little farther forward than the anus.

Length from anus to caudal end, 17 mm.; from anus to base of tentacles, 8 mm.

Taken at low tide on Laguna Beach.

Type—M. C. Z. 2, 182.

PHASCOLOSOMA HESPERA SP. NOV.

Somewhat resembling *P. procerum* in form, but with the proboscis more abruptly set off from the body and on the average narrower and especially much longer relatively to the latter. In the type the body proper is 8.5 mm. long, while the proboscis is 52 mm. long, i. e., about six times longer than the body, while in one paratype it is as much as 7.5 times longer. The body of the type is 2.6 mm. thick and the proboscis half or less than half this thickness. Body proper pointed at both ends, broadly subfusiform. The skin at the caudal end of the body is rather thickly studded with papillae, which are disally flat and dark colored over a pale and often constricted base. The papillae rapidly become fewer and more widely scattered over the middle and anterior regions of the body and over the proboscis, and at the same time become decidedly smaller and are often borne singly on low, rounded elevations; on the proboscis th epapillae are typically colorless. The two retractor muscles in the type have their origins in the anterior part of the body.

The type was secured in sand at Balboa, December 26, 1917. Paratyoes from eelgrass on Laguna Beach, September, 1917.

Type—M. C. Z. 2, 185.

A Study of the Food Habits of the Ithacan Species of Anura During Transformation*

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In recent years almost as much interest has been attached to the study of the habits of animals and to the relation to the environment as to the structure and classification. Naturally enough the food-habits are among those that can be most profitably studied; as an example I have to cite only the work of Professor S. A. Forbes of the University of Illinois on the food of fresh-water fishes. His results, embodied in a series of papers published by the Illinois State Laboratory of Natural History, have been very suggestive and an inspiration to investigation in allied groups. When, therefore, a study of the food-habits of various species of the Anura during their transformation period was suggested to me, it was gladly taken as a subject of some promise.

The purpose of the investigation was to learn something more definite than was already known concerning the food before and after transformation and to see how the change from the one kind to the other came about. It was thought that such knowledge might aid to some extent in frog-culture during this rather critical period of a frog's development.

The problem was undertaken with the advice and criticism of Doctor A. H. Wright of Cornell University. To him my sincere gratitude is hereby given, not only for his suggestion of the problem and for his help in carrying it out, but for the abundant material which he so generously put at my disposal and which was the result of much careful collecting on his part.

Largely because of the work he had been doing at Ithaca during the last ten years, material was available for all eight species of Anura occurring in the Cayuga Lake Basin of New York state. In all, 586 specimens were dissected, giving a fairly representative series for each of the species which were as follows:

Rana catesbeiana Shaw. The Bullfrog.
Rana clamitans Latreille. The Green-frog.
Rana sylvatica Le Conte. The Wood-frog.
Rana palustris Le Conte. The Pickerel-frog.
Rana pipiens Schreber. The Leopard- or Meadow-frog.
Hyla crucifer Wied. The Peeper.
Hyla versicolor Le Conte. The Tree-toad.
Bufo americanus Holbrook. The Common Toad.

METHODS

As specimens were collected in the field they were immediately killed, usually in formalin, in order that digestion would immediately cease. Each lot that was col-

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A contribution from the Zoological Laboratory of Cornell University of Ithaca, New York.

lected was kept separate and the data as to its time and place of collection were recorded. This data can be found under the discussion of the individual species. My part in the collecting was during the season of 1916, and during the following fall and winter the material was examined.

As complete information as possible was secured as to the stage of transformation; the length of the tail, condition of the mouth, length of the alimentary canal, its differentiation into stomach, small and large intestines, and the development of the front legs—all these facts were noted. Unfortunately at first the desirability of so complete a record was not realized and the bullfrog, which was the first species studied, did not receive as full treatment as those taken up later.

After the alimentary canal had been removed and its length had been measured, the contents were removed and identified. In many cases, prhaps a more exact determination of the forms found could have been carried out by specialists, but the kind of food rather than the exact species seemed the essential thing. For this reason a not very serious attempt was made below the identification to family, especially where digestion had proceeded to any extent.

WORK PREVIOUSLY DONE

Some very thorough investigation has been carried out on the food of the adults of several species, in America the most notable being that of Kirkland on the American toad, and of Drake on the meadow-frog. Kirkland[1] in an examination of 149 toad stomachs which had been collected in a number of situations, found that by bulk 98% of the food examined was animal, that 77% was made up of insects and, that of the insect food 11% was of beneficial forms, 22% neutral and 62% injurious. He made note, too, of the fact that the toad feeds largely at night and that in a single twenty-four hours it can fill its stomach to its complete capacity four times. He said, too, that the toad takes only living and moving forms; this fact is one repeated by other observers for other species of the Anura and agrees with my own results. As an example of the evident attractive power a moving object has for an Anuran I may mention a specimen in the Museum of the University of Denver. It is a toad probably of the Woodhouse variety, which was brought in dead and dried up and with the tip of a turkey wing projecting from the mouth. It had evidently been attracted by the small bunch of feathers being blown about and, having swallowed a part was not able to finish the process nor to disgorge because of the barbs of the feathers catching in the throat.

From the tables given by Kirkland one is led to infer that practically no aquatic forms enter into the toad's diet, a not very surprising fact when its terrestrial habits are remembered. Since many aquatic insects are attracted to electric lights, it is evident that a toad or frog feeding under the corner arc light can secure such forms without ever approaching water.

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[1]Kirkland, A. H., 1897. Habits, food and economic value of the American toad. (Bull. 46 of Hatch Exp. Station of the Mass. Agric. College, 1904.) Usefulness of the American toad. (Farmers Bull. 196, U. S. Dept. of Agriculture.)

In addition to the work of Kirkland some other work has been done by Garman[2] on the toad in Illinois and Kentucky, and has had in large part the same results, showing that many harmful insects are destroyed.

The work of Drake[3] mentioned above and dealing with the meadow-frog covered an examination of 209 stomachs. Mr. Drake says, "All the evidence indicates that the presence of substances other than those of an animal nature is merely incidental, and due to the mode and conditions of feeding," and "Nothing can be more natural, since the frog captures the greater part of its prey on the ground by means of its tongue, than that a small amount of foreign substances should be swept into the mouth along with the animals upon which it feeds. The frog's food consists of mollusks, crustaceans, myriapods, spiders and insects; in fact any sort of living creature is acceptable to it as both sense of taste and of smell are apparently obtuse."

In his work at Saranac Inn in the Adirondacks, which is reported in the "May-flies and Midges of New York," Professor Needham[4] spent some time in a study of the summer food of the bullfrog and in his report gives the contents of 16 stomachs. Of the 164 animals found 139 were insects, 18 were snails, three crustaceans, three spiders and two vertebrates, one bullfrog tadpole, and one meadow mouse. This assemblage differs largely from the food of the toad in that many aquatic forms are reported, some of which must have been taken under water, for example the nymph of the mayfly *Siphlurus alternatus* Say, which Professor Needham says never comes to the surface except for transformation. Other forms were the *Rana* tadpole, *Anax* nymph, chironomid larvæ, and a small copepod and some aquatic snails; while the water-striders, soldier-fly larvæ (Stratiomyidæ), gnat pupæ and transforming caddisflies taken were probably secured at the surface of the water.

The few others who have studied the food of the bullfrog have likewise found many vertebrates eaten. Brakeley[5] in twelve bullfrogs dissected found one mouse, one young bird, one frog, two toads, two carp, six mud-fish, one mud-turtle, besides of course, many insects and other invertebrates. Dyche's report[6] in 1914 on the contents of 30 bullfrog stomachs substantiates previous reports on the greed and rapaciousness of this species. He found that one specimen thirteen inches long had swallowed another about ten inches long and cites many other cases of cannibalism. Fourteen of his 30 species contained 32 fish, otherwise the diet was made up largely of crayfish, other crustaceans, insects, spiders and snails.

Brief mention of the feeding habits of the species of Anura is made by Miss Dickerson[7] who has evidently based some of her account on personal observation. Of especial interest here are remarks on the food of tadpoles. Concerning the tadpole of the toad she says, "These mouths are provided with horny jaws for scraping the tiny plants from their supports and for biting off the delicate ends of larger plants." In another connection, "The tadpoles of the wood-frog eat not only the green jelly mass from which they themselves hatch, but also the soft green spheres within the jelly masses vacated by young salamanders. Like other tadpoles, they

[2]Garman, H., 1901. The food of the toad. (Bull. 91, Agric. Exp. Station of Kentucky.)

[3]Drake, C. J., 1904. The food of Rana pipiens Shreber. (Ohio Naturalist, 14:257-269.)

[4]Needham, J. G., 1905. The summer food of the bullfrog (Rana catesbeiana Shaw) at Saranac Inn. (Bull. 86, New York State Museum.)

[5]Brakeley, J. H., 1885. Notes on carp and frog-culture. (Bull. U. S. Fish Com., 5:209-213.)

[6]Dyche, L. L., 1914. Ponds, pond fish, and pond fish culture. (Bull. No. 1 of Dept. of Fish and Game, Kansas.)

[7]Dickerson, Mary C. The Frog Book. (Doubleday Page and Co.)

act as scavengers by greedily devouring all dead animal matter of the pond." For the bullfrog tadpole she says, "The mouth is well fitted to bite the delicate ends of leaves and stems, or to scrape off the tender green or brown plants from sticks and stones. It is equally adapted for eating animal food. The bullfrog tadpole (like that of the green-frog and that of the wood-frog), is especially fond of any animal food available. Thus these tadpoles act as scavengers and dispose of dead fish or dead tadpoles even, that otherwise would become a menace to the living creatures of the pond."

Her remarks on the food of the adults bear out the statements made by other workers and show further that the bullfrog and the green-frog are the most aquatic of the eastern frogs, that the meadow- and pickerel-frogs are less so, while the wood-frog, peeper, tree-toad and common toad are even less inclined to be found in the water. The food is therefore expected to vary accordingly.

Her observations on moulting the skin are also of interest. "The green-frog moults the skin four or more times each year. If the frog is out of the water when the moulting takes place, the process is like that of the American toad and of the leopard-frog, and the skin is swallowed. If the moulting takes place in the water the skin may float off in large patches and is not eaten."

From this short review of the literature in regard to the food of the Anura of this country, it can readily be seen that there are many statments as to the food of the adults and some remarks are even made as to that of the tadpole, but I have found nothing as to food during transformation, except that the tail is absorbed by phagocytic action and is used. It shall therefore be my attempt in the following pages to take up in more detail the food of the adult tadpoles, of the transforming ones, and of the young frogs.

GENERAL DISCUSSION OF TRANSFORMATION

One of the first evidences externally of transformation and the one most greatly affecting the food situation is the shedding of the horny plates characteristic of the tadpole's mouth. After this takes place the alimentary canal decreases to one-tenth or one-twelfth of its larval length, and at the same time becomes differentiated into distinct portions. The larval digestive tube is merely a long tube, that of the young frog has a widened and thick muscular-walled stomach, a long narrow small intestine, and a much shorter but likewise thin-walled large intestine. In the specimens dissected the longest larval alimentary tract found in the bullfrog was 1070 mm., the average after decrease in length was from 85 to 95 mm.; for the green-frog the two measurements were 450 and 50 to 60 respectively, for the wood-frog 200 and 18 to 20, for the pickerel-frog 400 and 30 to 35, for the meadow-frog 530 and 30 to 40, for the peeper 88 and 10 to 15, for the tree-frog 170 and 15 to 18, and for the toad 110 and 10 to 15. While all this change is going on the mouth is gradually increasing in size to one many times larger than the tadpole mouth. Obviously while the mouth is still very small it is scarcely capable of taking in any food, its horny plates having been lost. In order that the materials eaten may be swallowed whole and not nibbled off, the mouth has to be considerably enlarged. It is not strange then, to find that without exception all eight species go through a period of fasting as far as taking food from the outside is concerned. An examination of the data

given under the separate species will show that many of the individuals studied, and practically all of these in which the mouth was enlarging, contained no food. It seems hardly necessary to say in this connection that the absorption of the tail must make possible this period of fasting.

It must take some little time for the food to pass through the long alimentary canal of the larva, since it was quite noticeable that in many of those examined in which the mouth plates had recently been shed, the caudal portion still contained the mud and other contents typical of the larva and which had probably been taken into the body when the mouth plates were still in place.

The length of the body without considering the tail, remains almost unchanged during transformation, but the rotund aspect of the tadpole gives way to the flatter and more angular one of the young frog. The appearance of the front legs, the left one coming out through the spiracle and the right one breaking through the skin, as well as the shrinking of the tail are further indications of the progress made in transformation. Usually the tail is almost gone before feeding as a carnivor begins.

It is to be noticed that in the data given for the bullfrog almost every transforming individual is reported as having swallowed some of its own cast epidermis. This is true to a lesser degree of the other species, probably because the much smaller size of such species as the tree-toad and the toad makes the rcognition of epidermis in the alimentary tract of preserved specimens more uncertain. The frequent occurrence, one might say almost universal occurrence, of epidermis in transforming individuals must mean frequent moulting. Doubtless this is true, especially of the tail, which shrinks rapidly and might naturally shed its epidermis. That the shedding of the skin takes place in the water is evidenced by the threads of *Spirogyra* and *Zygnema* often wrapped up in it as if during seizing and swallowing.

The discussion of transformation may be concluded, then, by saying that it is accompanied by a period of fasting during which time, in all eight species, the food-getting and food-assimilating apparatus is rebuilt and changed from one suitable to a form largely herbivorous and at least feeding only on dead animal material, to one which will permit of the predaceous and carnivorous habits of a frog or toad.

PRESENTATION OF DATA FOR THE SPECIMENS EXAMINED

In the following pages lists are given of the specimens dissected with data showing the degree of transformation and the contents of the alimentary canal. The word "stomach-content" is not sufficent here; for in many cases the stomach was almost empty while the large intestine contained large amounts of food; in the case of insects, passage through the digestive tract in this way had not sufficiently changed many specimens to make it impossible to identify them to family at least. In the data given under each species, "No." refers to the number of the specimen, "Body" to the length in millimeters, measuring from the tip of the head to the base of the tail; "Tail" to the length of the tail in millimeters, "Mouth" to the condition of the mouth, whether that of the tadpole with the horny plates or with these shed, or with the mouth enlarged; "Ali. Can." to the length in millimeters and to the condition of the alimentary canal; "Fore Legs" to the presence or absence of the front legs; "Lot" to the lot to which the particular specimen belonged, and "Food" to the material found in the digestive tract.

Rana catesbeiana Shaw. The Bullfrog.

Total of 104 specimens. Lot 1, Dr. A. H. Wright and Dr. A. L. Leathers, Wood's Hole, Mass., July 16, 1909. Lot 2, Wright and myself, July 10, 1916, Dwyer's Pond, Ithaca; lot 3 same, but on July 17. Lot 4, Dr. Wright, July 7, 1911, Beaver Brook Mill Pond, Ithaca.

Table 1. Data for Rana catesbeiana

No.	Body	Tail	Mouth	Ali. Can.	Fore Legs	Lot	FOOD
1	48	87	tadpole	1070, tadpole	none	4	Mud with Meridion, Cymbella, Navicula, Diatoma, Frustulia, Pinnularia, Oscillatoria
2	45	95	tadpole	980, tadpole	none	4	Mud with Epithemia, Navicula, Pinnularia, Diatoma, Synedra, Nitzchia, Cymbella, Meridion, Ulothrix, Spirogyra, Oscillatoria
3	51	118	changing	240, stom. small	present	2	Green algal threads
4	51	115	tadpole	140, stom. small	"	2	Greenish material, not identifiable
5	51	95	changing	100, stom. & int.	"	2	Epidermis, Spirogyra, Zygnema
6	50	85	small	115 " "	"	2	Epidermis, Spirogyra
7	55	85	"	" "	"	1	Nothing
8	53	80	"	" "	"	2	Epidermis, Spirogyra
9	50	80	"	165 " "	"	1	Epidermis
10	53	70	"		"	1	Nothing
11	54	70	"		"	1	Nothing
12	50	70	"		"	1	Nothing
13	57	68	"	110, stom. & int.	"	1	Epidermis
14	52	68	"	" "	"	1	Epidermis, piece of plant tissue
15	53	65	"	100 " "	"	1	Epidermis
16	51	65	"		"	1	Epidermis, Insecta 1
17	52	64	"		"	1	Epidermis
18	50	60	"	100, stom. & int.	"	1	Epidermis
19	48	60	"		"	1	Epidermis?
20	51	60	"	stom. & int.	"	1	Epidermis?
21	53	58	"	94 " "	"	1	Epidermis
22	50	57	"	85 " "	"	1	Epidermis
23	52	55	"	95 " "	"	1	Epidermis
24	53	55	"	97 " "	"	1	Epidermis, some plant tissue
25	51	52	"		"	1	Nothing
26	45	52	"	78, stom. & int.	"	1	Epidermis
27	51	52	"	88 " "	"	1	Epidermis
28	50	50	"	85 " "	"	1	Epidermis
29	50	50	"		"	1	Nothing
30	52	50	"		"	1	Epidermis
31	52	50	"	stom. & int.	"	1	Epidermis?
32	55	48	"	" "	"	1	Epidermis
33	54	48	"		"	1	Epidermis
34	52	47	"	stom. & int.	"	1	Epidermis
35	50	46	"		"	1	Epidermis
36	54	46	"	stom. & int.	"	1	Epidermis?
37	50	45	"		"	1	Epidermis
38	51	45	"	115, stom. & int.	"	1	Epidermis
39	52	45	"		"	1	Epidermis
40	49	45	"	stom. & int.	"	1	Epidermis
41	53	43	"	95 " "	"	1	Epidermis, sand, moss-leaves
42	49	43	"	96 " "	"	1	Epidermis
43	53	43	"	" "	"	1	Epidermis
44	51	40	"	90 " "	"	1	Epidermis
45	52	40	"	82 " "	"	1	Epidermis, some plant tissue
46	52	40	"		"	1	Epidermis
47	50	40	"	85, stom. & int.	"	1	Epidermis, Collembola 1
48	54	40	"		"	1	Nothing
49	50	38	"	stom. & int.	"	1	Epidermis
50	50	35	"	95 " "	"	1	Nothing
51	50	35	"	85 " "	"	1	Epidermis
52	50	35	"		"	1	Epidermis
53	51	35	"	stom. & int.	"	1	Nothing
54	53	32	"		"	1	Epidermis
55	53	32	"	stom. & int.	"	1	Epidermis? Copepoda 2
56	53	30	"		"	1	Epidermis
57	52	28	"	95, stom. & int.	"	1	Epidermis, plant tissue
58	50	28	"	" "	"	1	Epidermis, Copepoda 1, Collembola 1
59	50	27	"	" "	"	1	Nothing

Table 1. Data for Rana catesbeiana---Continued

No.	Body	Tail	Mouth	Ali. Can.			Fore Legs	Lot	FOOD
60	53	25	"	105	"	"	"	1	Epidermis
61	50	25	"	90	"	"	"	1	Epidermis
62	53	20	"				"	1	Epidermis, Collembola 1, Capsidae 1, Diptera 1
63	51	20	"	93,	stom. & in.t		"	1	Nothing
64	50	20	"	88	"	"	"	1	Epidermis
65	55	20	"		"	"	"	1	Epidermis
66	51	19	"	91	"	"	"	1	Philoscia (Oniscidae) 1
67	53	18	"				"	1	Epidermis
68	55	17	"				"	1	Oribatella (Acarina) 1, plant tissue
69	52	15	"	90,	stom. & int.		"	1	Epidermis, green algae
70	52	15	"	100	"	"	"	1	Epidermis
71	54	15	"	95	"	"	"	1	Epidermis
72	52	14	"		"	"	"	1	Epidermis
73	54	14	"				"	1	Nothing
74	52	12	"		stom. & int.		"	1	Epidermis
75	54	12	"		"	"	"	1	Epidermis, Curculionidae 1
76	51	10	"	93	"	"	"	1	Epidermis
77	52	9	"	85	"	"	"	1	Epidermis?
78	53	8	"		"	"	"	1	Lestes vigilax (Zygoptera) 1, seed
79	54	7	"		"	"	"	1	Staphylinidae 1, Formicidae 1
80	58	7	"		"	"	"	1	Difflugia 3, Hydrachna 1, Aphididae 1, Myrmicidae 1
81	53	5	"	115	"	"	"	1	Epidermis
82	53	5	"		"	"	"	1	Collembola 3, Rana tadpole 1
83	49	5	"	90	"	"	"	1	Epidermis, Oritabidae 1, Insecta 1, Aphididae 1
84	52	5	"	95	"	"	"	3	Epidermis, Spirogyra
85	52	4	"	95	"	"	"	1	Collembola 1, Coleoptera 2, Staphylinidae 1, Laccophilus 1, Dascyllidae 1 larva, Formicidae 1, egg 1, achene of Scirpus
86	57	4	"		"	"	"	1	Epidermis, unidentifiable material
87	53	4	"		"	"	"	1	Collembola 1, plant fiber
88	53	4	"		"	"	"	1	Epidermis, unidentifiable material
89	55	4	"		"	"	"	1	Nothing
90	52	3	"	90	"	"	"	1	Acarina several, Lestes nymph
91	52	3	"		"	"	"	1	Nothing identifiable
92	50	3	"	85	"	"	"	1	Collembola 1, Cercopidae 1
93	50	2	"		"	"	"	1	Acarina 1, Collembola 1, Cercopidae 1, Agromyzidae 1, Anthonomus (Curculionidae) 1, Aphodius 1, bits of Sphagnum
94	53	1	"		"	"	"	1	Coenagrionidae 1, Carabidae 1
95	55	0	"	145	"	"	"	3	Gerridae 1, Lepidoptera 1 larva, Cladophora, Spirogyra
96	53	0	"		"	"	"	1	Coenagrioninae 1, nymph
97	50	0	"		"	"	"	1	Copepoda 1, Agromyzidae 1, Elateridae
98	93	0	"		"	"	"	1	Elateridae 1, young Rana catesbeiana, grass seed
99	80	0	"		"	"	"	1	Clubionidae (Araneida) 2, Oribatidae 1, Collembola 3, Creniphilus 1, Coleoptera 1, Sphagnum, twig
100	56	0	"		"	"	"	1	Oribatidae many, Collembola many, Panorpidae, 1, Cercopidae 1, Agromyzidae 1, Coleoptera 1, Hydrophilidae 1 larva
101	63	0	"		"	"	"	1	Aphididae several, Agromyzidae 2
102	80	0	"		"	"	"	1	Nauplius many, Copepoda several, Collembola 1, Coenagrioninae 1, Coleoptera 1, Elateridae 1, Curculionidae 1, Hymenoptera 1, Aphididae 1, Bidens seed, Sphagnum leaves, plant fibers
103	73	0	"		"	"	"	1	Difflugia, Copepoda many, Acarina several, Coenagrioninae 1, Zygoptera nymph, Psocidae 1, Hemiptera 1, Coleoptera 1, Chrysomeelidae 1, Carabidae, Curculionidae 1, Hydrophilidae 1, young Bufo, moss, thistle-down
104	80	0	"		"	"	"	1	Pentatomidae 1, Rhyncophora 2, Hydrophilidae 1, Apidae 1, much dirt, straw, moss-leaves, seeds, pieces of chitin

Rana clamitans Latreille. The Green-frog.

Total of 87 specimens. Lot 1, Crystal Beach, Canada, June, 1914; lot 2, Cascadilla Creek, Ithaca, July 22, 1907; lot 3, Bool's Backwater Ithaca, June 30, 1906; lot 4, Slaughter House Ponds, Ithaca, June 20, 1906; lot 5, same, June 10, 1907; lot 6, same, June 27, 1911; lot 7, same, June 30, 1911; lot 8, Dwyer's Pond, Ithaca, date not given; lot 9, Slaughter House Ponds, June 29, 1907; lot 10, same, June 29, 1907; lot 11, Cascadilla Ponds, Ithaca, July 7, 1916; lot 12, Dwyer's Pond, July 10, 1916; lot 13, Wood's Hole, Mass., July 16, 1909; lot 14, Dwyer's Pond, July 27, 1916; lot 15, Michigan Hollow Pond, Ithaca, Aug. 5, 1916; lot 16, Biological Station, Ithaca, June 30, 1911; lot 17, Bool's Backwater, Ithaca, Sept., 1912; lot 18, Ithaca, June 21, 1915. Lots 1-10, 16, 17, 18 collected by Dr. Wright; lot 13 by Dr. Wright and Dr. A. L. Leathers; lots 11 12, 14, 15 by Dr. Wright and myself.

Table 2. Data for Rana clamitans

No.	Body	Tail	Mouth	Ali. Can.		Forelegs	Lot	FOOD
1	34	63	tadpole	tadpole,	230	one	7	Mud with Eunotia, Diatoma, Navicula, Synedra, Spirogyra, Zygnema, Anabæna.
2	32	60	tadpole	"	290	none	7	Mud with Diatoma, Navicula, Eunotia, Nitzchia, Synedra, Paramœcium, Zygnema, Cladophora, Spirogyra, Mougeotia.
3	29	60	tadpole	stomach,	110	present	11	Nothing.
4	29	55	"	"	160	none	12	Mud with Oscillatoria, Navicula, Spirogyra, Nitzchia, Cymbella, Ceriodaphnia, Euglena ?
5	30	53	"	tadpole,	440	none	12	Plant tissue, algal filaments.
6	28	53	"	"	300	none	12	Mud with Synedra, Pinnularia, Navicula, Diatoma, Gomphonema, Nitzchia, Oscillatoria, Euglena ?
7	32	52	"	"	450	none	4	Mud
8	28	50	"	stomach,	250	"	9	Mud with tadpole teeth, Zygnema, Microspora, Diatoma, Navicula, Gomphonema.
9	29	60	"	"	110	present	11	Nothing.
10	32	45	"	tadpole,	440	none	7	Mud with Spirogyra, Mougeotia, Zygnema, Oscillatoria, Eunotia, Navicula, Synedra, Tabellaria, Nitzchia, Melosira, Gomphonema, Closterium.
11	31	55	changing	stomach,	120	present	16	Nothing
12	30	53	small	"	55	"	11	Nothing
13	31	53	"	"	94	"	16	Nothing
14	33	52	tadpole	tadpole,	90	"	12	Nothing
15	27	51	small	"	90	"	12	Nothing
16	31	50		stom. & int.	57	"	11	Epidermis
17	31	55	small	stomach,	120	"	16	Nothing
18	31	47	"	stom. & int.		"	11	Nothing
19	30	46		" "	55	"	11	Epidermis ?
20	31	46		" "	54	"	10	Epidermis, algal filaments
21	32	46		stomach,	50	"	10	Epidermis
22	28	46	"	"	185	"	12	Mud with Navicula, Gomphonema, Oscillatoria, Spirogyra, cells of pine wood.
23	28	46	"	stom. & int.	45	"	14	Epidermis, Spirogyra
24	31	45		" "	40	"	11	Nothing
25	31	45		" "	45	"	11	Epidermis
26	32	45		" "	60	"	11	Epidermis ?
27	35	43		" "	45	"	11	Epidermis, Spirogyra, Zygnema
28	27	42	small	" "	55	"	12	Epidermis ?
29	28	40	"	" "	55	"	11	Nothing
30	30	40	"	" "	65	"	10	Epidermis
31	32	40		" "	40	"	11	Epidermis
32	29	40		" "	42	"	12	Epidermis, Spirogyra
33	32	38	one-half	" "	65	"	111	Epidermis ?
34	30	34	one-fourth	stomach,	84	"	16	Nothing
35	33	50		stom. & int.	100	"	6	Nothing
36	33	32		stomach,	60	"	3	Epidermis

Table 2. Data for Rana clamitans---Continued

No.	Body	Tail	Mouth	Ali. Can.		Fore Legs		Lot	FOOD
37	26	30		stom. & int.		45	"	8	Epidermis, plant tissue
38	32	16		"	"	44	"	9	Epidermis, Spirogyra, Zygnema
39	35	14		"	"	53	"	1	Epidermis ?
40	29	13		"	"	45	"	9	Epidermis, plate of larval teeth
41	34	12		"	"	72	"	4	Epidermis, small seed?
42	30	11		"	"	45	"	11	Epidermis ?
43	31	10		"	"	50	"	11	Epidermis
44	31	5		"	"	46	"	5	Epidermis, sand
45	30	4		"	"	50	"	11	Epidermis
46	35	2		"	"	50	"	1	Agromyzidæ 1, Coleoptera 1, Dytiscidæ 1
47	36	2		"	"	50	"	1	Epidermis, Agromyzidæ 2, Leptidæ 2, Formicidæ 1
48	30	2		"	"	58	"	5	Lycosidæ 1, Lygæidæ 1, Ceratopogon larva, Curculionidæ 2, Braconidæ 1
49	32	2		"	"	53	"	11	Tipulidæ 2, Megilla maculata (Coccinellidæ)
50	34	2	large	"	"	50	"	16	Epidermis, Drassidæ 1
51	31	2	"	"	"	57	"	16	Insecta 1
52	36	1		"	"	60	"	1	Zygoptera nymph, Leptidæ 1, Formicidæ 1
53	33	5	large	"	"	60	"	17	Tipulidæ 1
54	35	0		"	"	58	"	1	Lycosidæ and egg-sac, Scarabæidæ 1, Formicidæ
55	34	0		"	"	50	"	1	Epidermis, Coleoptera 4
56	31	0		"	"	40	"	1	Pelecypoda, Agromyzidæ 1, Coleoptera 1, Formicidæ 1
57	37	0		"	"	85	"	2	Phalangidæ 1, Jassidæ 1, dirt and trash
58	35	0		"	"	85	"	4	Coleoptera 1, Staphylinidæ 1, Diptera 1
59	31	0		"	"	80	"	7	Lymnæidæ 3, Nematoda 3, Araneida 1, Insecta 1, larva, Capsidæ 1, Jassidæ 1, Lepidoptera larva
60	32	0		"	"	65	"	8	Nematoda 1, Panorpidæ 1, Lepidoptera larva, Formicidæ 2, mass of eggs, fruit of Juncus
61	32	0		"	"	50	"	11	Epidermis ?, Dictynus (Araneida), Tipulidae 1
62	33	0		"	"	45	"	11	Trematoda 1, Limnobatidæ 1
63	41	0		"	"	110	"	13	Libelluline nymph, Hydrophilidæ 1, Psilopus (Dolichopodidæ) 1, Plant material and sand
64	42	0		"	"	85	"	13	Araneia 1, Anisoptera nymph, Curculionidæ 1, Formicidæ 1, Myrmicidæ 1, Poneridæ 1
65	41	0		"	"	70	"	13	Diplopoda 1, Oniscidæ 1, Araneia 1, Jassidæ 1, Corixidæ 1, Heteroneuridæ 1, Diptera 1, Leptidæ 1, Anthomyidæ 1, Curculionidæ 3, Ichneumonidæ
66	39	0		"	"	80	"	15	Ostracoda 1, Trematoda 4, Gastropoda 1, Jassidæ, Coleoptera 1, Dytiscidæ 1, Chrysomelidæ 1, Rhyncites bicolor 1, Ephyhdridæ 1, Formicidæ
67	38	0	large	"	"	110	"	16	Lymnæa 2, Porcellio rathkei 6, Geometridæ 1, larva, Carabidæ 4
68	33	0	"	"	"	81	"	16	Porcellio 1, grass, mud, plant fibers
69	35	0	"	"	"	70	"	16	Coptocychla guttata 1, Diptera larva, Carabidæ larva, bits of grass
70	40	0		"	"	130	"	16	Porcellio 2, Theridiidæ 1, Carabidæ 4, Mud grass
71	31	0	large	"	"	52	"	16	Epidermis, Capsidæ 1, Empididæ 1, Carabidæ, Tenebrionidæ 1
72	38	0	"	"	"	100	"	16	Araneida 1, Insecta 1, Carabidæ 1, larva and 1, adult, mud, plant fiber
73	33	0	"	"	"	62	"	16	Hemiptera 1, Diptera 1, Carabidæ 1
74	32	0	"	"	"	64	"	16	Coleoptera 1, Carabidæ 1, Curculionidæ 1
75	35	0	"	"	"	80	"	16	Epidermis Lumbricidæ 1, Carabidæ 1, Chrysomelidæ
76	35	0	"	"	"	72	"	16	Polygra ? (Castropoda) 1
77	35	0	"	"	"	94	"	16	Oniscidæ 6, Lymæa 2, Lithobius 1, Diptera 1, Coleoptera 1
78	38	0	"	"	"	96	"	16	Oniscidæ 4, Lumbricidæ, Lymnæa 1, Argiopidæ 1, Potomogeton leaf
79	36	0	"	"	"	63	"	16	Argiopoidea 1, Diptera 1, Empididæ 2, Coleoptera 1, Potamogeton leaf

Table 2. Data for Rana clamitans---Continued

No.	Body	Tail	Mouth	Ali. Can.		Fore Legs	Lot	FOOD
80	35	0	"	" "	86	"	16	Nothing identifiable
81	34	0	"	" "	75	"	16	Capsidæ 1, Jassidæ 1, Diptera 1, Empididæ 1, Carabidæ 3
82	36	0	"	" "	78	"	18	Phalangidæ 1, Philænus lineatus 1, Diptera adult and larga, Carabidæ 2, Formicidæ 1, Salix fruit; epidermis
83	34	0	"	" "	65	"	18	Nothing identifiable
84	36	0	"	" "	84	"	18	Phalangidæ 1, Carabidæ 1, Diptera 1, larva and 1 adult, Leptidæ 1
85	37	0	"	" "	72	"	18	Oniscidæ 18 nymphs, Hemiptera 1, Cercopidæ 1 nymph, Capsidæ 1, Diptera larva, Carabidæ 2, Rhyncophora 2.
86	37	0	"	" "	100	"	18	Hemiptera 1, Tipulidæ 1, Carabidæ 1, Salix fruits 3, straw, unidentifiable material
87	37	0	"	" "	96		18	Oniscidæ 1, Diplopoda 1, Dolichopodidæ 1, Coleoptera larva, Formicidæ 3 epidermis, Salix fruits 6

Rana sylvatica Le Conte. The Wood-frog.

Total of 100 specimens. Lot 1, Hamburg, N. Y., July 1, 1907; lot 2, Beehive Pond, Ithaca, July 22, 1907; lot 3, Cross-road Pond, Ithaca, July 4, 1907; lot 4, Beehive Pond, June 28, 1911; lot 5, Cross-road Pond, Ithaca, July 5, 1907; lot 6, Beehive Pond, July 31, 1907; lot 7, Beehive Pond, July 8, 1908. Lot 1 collected by Dr. A. A. Allen of Cornell University; lot 3 by Dr. Wright and Dr. H. D. Reed; the others by Dr. Wright.

Table 3. Data for Rana sylvatica

No.	Body	Tail	Mouth	Ali. Can.		Forelegs	Lot	FOOD
1	22	36	tadpole	tadpole,	200	none	4	Mud with Cymbella, Navicula, Nitzchia, Diatoma, Amphora, Fragillaria, Epithemia, Meridion, Microspora
2	16	28	"	"	65	"	3	Mud with Difflugia, Eudorina, Oscillatoria
3	19	28	"	stomach,	60	present	4	Mud with Navicula, Pinnularia, Meridion, Stephanodiscus, Arcella. Epidermis?
4	15	25	"	tadpole,	130	none	2	Mud with Spirogyra, Oscillatoria, Closterium, Navicula
5	18	20	"	stomach,	105	present	4	Mud with Arcella, Diatoma, Navicula, Synedra, Scenedesmus
6	13	14	"	stom. & int.	28	none	1	Plant tissue, fibers; Navicula
7	12	12	"	stomach,	15			Nothing
8	18	30	small	"	37	present	4	Nothing identifiable
9	18	28	"	"	35	"	1	Nothing
10	18	27	"	stom. & int.	28	"	4	Nothing
11	17	24	"	" "	30	"	5	Nothing
12	16	23	"	" "	25	"	3	Nothing
13	18	23	"	stomach,	53	"	4	Some mud with Navicula and Diatoma
14	15	22	"	stom. & int.	18	"	7	Nothing
15	16	21	"	" "	24	"	3	Epidermis
16	17	20	"	" "	24	"	3	Nothing
17	13	20	"	" "	18	"	7	Nothing
18	15	20	"	tadpole,	14	"	7	Mud with Navicula and Fragillaria
19	14	19	"	"	14	"	7	Nothing
20	19	18	"	stom. & int.	20	"	4	Diatoma, Mougeotia
21	14	18	changing	tadpole,	40	"	7	Mud with Gomphonema and Synedra
22	19	16	small	stom. & int.	28	"	4	Nothing
23	13	15	"	" "	18	"	1	Nothing identifiable
24	12	13	"	stomach,	21	none	1	Plant tissue
25	13	13	"	tadpole		"	7	Mud with Diatoma, Navicula, Gomphonema, Fragillaria
26	12	12	large	stomach,	17	present	1	Nothing
27	20	11	small	"	31	"	5	Epidermis

Table 3. Data for Rana sylvatica---Continued

No.	Body	Tail	Mouth	Ali. Can.	Fore Legs	Lot	FOOD
28	18	10	one-half	stom. & int.	18 "	1	Nothing
29	13	10	small	" "	18 "	1	Epidermis
30	15	10	"	" "	21 "	7	Nothing
31	13	9	large	" "	15 "	1	Plant tissue and fibers
32	19	9	"	" "	15 "	4	Epidermis ?, Zygnema, Mougeotia, Tribonema, Cymbella, Navicula, Fragillaria
33	17	8	"	" "	15 "	3	Epidermis ?
34	18	8	small	" "	25 "	4	Epidermis ?
35	18	7	one-half	" "	20 "	5	Epidermis, Zygnema
36	18	5		" "	16 "	5	Epidermis ?
37	18	5	large	" "	20 "	5	Epidermis ?
38	19	5	"	" "	21 "	4	Epidermis ?, threads of Mougeotia and Zygnema
39	12	5	"	" "	13 "	1	Plant tissue
40	20	5	small	" "	26 "	4	Epidermis, Zygnema, Mougeotia, Oscillatoria
41	19	4		" "	22 "	4	Epidermis ?, Spirogyra, Mougeotia
42	17	4	large	" "	"	5	Nothing
43	18	4		" "	17 "	5	Epidermis ?
44	18	3		" "	14 "	5	Nothing
45	18	3	large	" "	16 "	5	Nothing
46	18	2	"	" "	20 "	5	Epidermis, Zygnema
47	15	2	"	" "	18 "	7	Collembola 7
48	15	2	"	" "	15 "	2	Epidermis
49	18	2		" "	16 "	5	Epidermis
50	18	2		" "	25 "	3	Epidermis, Psocidæ 1
51	17	2		" "	25 "	3	Epidermis ?
52	18	2	large	" "	22 "	5	Epidermis
53	18	2		" "	21 "	5	Epidermis ?
54	17	2		" "	17 "	5	Epidermis, Zygnema
55	19	1	"	" "	20 "	5	Epidermis
56	17	1	"	" "	21 "	5	Epidermis, Psocidæ 1
57	17	1		" "	23 "	5	Epidermis
58	17	1		" "	18 "	5	Nothing
59	17	1		" "	26 "	6	Planorbis 1, Collembola 1, Chrysomelidæ 1, Proctrotrupidæ
60	15	1		" "	23 "	6	Asellus 1, Chironomidæ 1, Proctrotrupidæ 1
61	17	1	large	" "	20 "	5	Epidermis, Diptera 1
62	17	1	"	" "	19 "	5	Mud with Spirogyra and Eudorina
63	18	1	"	" "	18 "	5	Eudorina, Navicula, Oscillatoria
64	13	1	"	" "	16 "	1	Acarina 1, Corrodentia 1, Diptera 1, Chironomidæ 1 larva, Hydrophilidæ 1 larva
65	16	1		" "	20 "	3	Coleoptera larva
66	17	1		" "	20 "	3	Epidermis
67	19	1		" "	25 "	4	Epidermis
68	15	1		" "	19 "	2	Acarina 1, Diptera 1
69	17	1		" "	25 "	6	Psocidæ 2, Cynipidæ 1, Proctrotrupidæ 1
70	13	0		" "	19 "	1	Hydrachnidæ 2, Hydrophilidæ 1
71	14	0		" "	18 "	1	Ephydridæ 1, Chrysomelidæ 1
72	13	0		" "	19 "	1	Aphididæ 1, Curculionidæ 1, Proctrotrupidæ 1
73	12	0		" "	16 "	1	Chironomidæ larva, some unidentifiable material
74	14	0		" "	19 "	1	Diptera 1, Hydrophilidæ larva
75	15	0		" "	20 "	2	Collembola 1, Corredentia 1, plant tissue
76	15	0		" "	16 "	2	Collembola 2, Hydrophilidæ larva, Cynipidæ 1
77	15	0		" "	19 "	2	Ephydridæ 1, Cynipidæ 1, unidentifiable material
78	17	0		" "	21 "	5	Araneia 1, Aphididæ 1, Diptera 2, plant tissue
79	18	0		" "	24 "	5	Insecta larva, Lygæidæ 1, unidentifiable material
80	17	0		" "	20 "	5	Green algæ
81	17	0		" "	28 "	6	Planorbis 3, Oniscidal, Collembola 3, Heteroptera 1, Braconidæ 1
82	16	0		" "	23 "	6	Collembola 7, Diptera 1, Proctrupidæ 1, Braconidæ 1, 4 anthers
83	17	0		" "	27 "	6	Diptera 3, Carex seed
84	16	0		" "	27 "	6	Epidermis, Collembola 1, Hydrophilidæ larva, sand, Proctrotrupidæ 2, anther 1

Table 3. Data for Rana sylvatica---Continued

No.	Body	Tail	Mouth	Ali. Can.		Fore Legs	Lot	FOOD
85	16	0	"	"	22	"	6	Insecta 1, Jassidæ 1, Diptera 1, Chironomidæ 1, Tipulidæ 1, Hydrophilidæ 1
86	17	0	"	"	27	"	6	Acarina 1, Chironomidæ 4 larvæ, Lepidoptera larva
87	15	0	"	"	22	"	6	Difflugia 1, Acarina 1, Collembola 2, Diptera 2 larvæ, Phoridæ 1, seed, stellate trichomes of plant
88	17	0	"	"	24	"	6	Jassidæ nymphs
89	16	0	"	"	23	"	7	Collembola 3, Fulgoridæ 1, Staphylinidæ 1, Lepidoptera 2 larvæ, Diptera 1
90	17	0	"	"	27	"	7	Curculionidæ 1, Phoridæ 1, Braconidæ 1, Proctrotrupidæ 1
91	17	0	"	"	35	"	7	Lycosidæ 1, Phoridæ 1, Anthomyidæ 1, Staphylinidæ, Proctrotrupidæ 1, Cynipidæ 1, Chalcididæ 1
92	16	0	"	"	22		7	Diptera 1, Chalcididæ 1
93	17	0	"	"	28	"	7	Diptera 1, Phoridæ 1, Chalcididæ 1
94	17	0	"	"	28	"	7	Araneida 1, Collembola 5, Diptera 1, Coleoptera 1, Chalcididæ 1
95	15	0	"	"	18	"	7	Collembola 4, Diptera 1
96	15	0	"	"	25	"	7	Collembola 2, Phoridæ 1, Diptera 1, Ichneumonidæ 1, bit of down feather
97	15	0	"	"	28	"	7	Linyphiidæ 1, Fulgoridæ 1, Diptera 1, Coleoptera 1, Hydrophilidæ 1, Curculionidæ 1, insect eggs
98	14	0	"	"	28	"	7	Linyphiidæ 2, Psocidæ 5 nymphs, Diptera 2, Proctrotrupidæ 2
99	15	0	"	"	23	"	7	Oribatidæ 1, Coleoptera larva, Proctrotrupidæ 1, one empty anther
100	13	0	"	"	23	"	7	Psocidæ 3 nymphs, Lepidoptera larva, Diptera 1, Coleoptera 1, Staphylinidæ 1

Rana palustris Le Conte. The Pickerel-frog.

Total of 100 specimens. Lot 1, Michigan Hollow Pond, Ithaca, Aug. 5, 1916; lot 2, Bool's Backwater, Ithaca, Sept. 1, 1912; lot 3, same, July 29, 1907; lot 4, Crossroads Pond, Ithaca, Aug. 6, 1907; lot 5, Bool's Backwater, Aug. 6, 1907; lot 6, no date nor locality. Lot 1 collected by Dr. Wright and myself; lots 3, 4, 5 by Dr. Wright; lots 2 and 6 presumably by him.

Table 4. Data for Rana palustris

No.	Body	Tail	Mouth	Ali. Can.		Forelegs	Lot	FOOD
1	25	48	tadpole	tadpole,	200	none	1	Mud with Mougeotia, Merismopedia, Microcystis, Scenedesmus, Navicula, Pinnularia, Diatoma, Eunotia, Nitzchia, Cosmarium, Closterium, Pandorina
2	25	47	changing	tadpole,	168	"	2	Mud with Navicula, Diatoma, Synedra, Epithemia, Gomphonema, Oscillatoria, Mougeotia, Spirogyra, Zygnema, Scenedesmus, Closterium
3	23	44	tadpole	"	180	"	1	Mud with Gomphonema, Navicula, Diatoma, Pinnularia, Scenedesmus, Clostetrium, Cosmarium, Merismopedia
4	24	33	"	"	400	"	5	Mud with Difflugia, Diatoma, Navicula, Synedra, Eunotia, Gomphonema, Nitzchia, Melosira, Scenedesmus, Epithemia, Spirogyra
5	22	30	changing	"	135	one	3	Mud with Navicula, Oedogonium, many Strongyllidæ, the latter probably parasites
6	23	40	small	stomach,	120	one	1	Mud with Merismopedia, Oscillatoria, Closterium, Scenedesmus, Cosmarium, Navicula, Protozoan parasite

Table 4. Data for Rana palustris---Continued

No.	Body	Tail	Mouth	Ali. Can.	Fore Legs		Lot	FOOD
7	24	40	small	stomach,	70	present	4	Nothing
8	27	44	"	"	65	"	1	Nothing
9	23	43	changing	"	64	"	1	Mud with Closterium, Paramœcium, Pleurococcus, plant tissue
10	25	42	small	"	55	"	1	Epidermis ?
11	21	24	"	"	70	"	3	Little mud at end of ali. can.
12	24	41	"	"	54	"	1	Nothing
13	30	46	"	"	46	"	1	Epidermis ?
14	25	46	"	"	45	"	1	Nothing
15	25	40	"	"	31	"	1	Nothing
16	26	40	"	"	32	"	4	Nothing
17	27	38	"	"	56	"	2	Nothing
18	26	39	"	"	43	"	4	Nothing
19	25	38	"	stom. & int.	38	"	1	Nothing
20	27	38	"	stomach,	36	"	4	Nothing
21	27	33	"	"	44	"	2	Nothing
22	26	33	"	"	46	"	2	Nothing
23	23	33	"	"	33	"	1	Nothing
24	27	33	"	"	27	"	4	Epidermis
25	22	33	"	"	28	"	5	Nothing
26	25	30	"	"	33	"	2	Nothing
27	25	29	"	"	30	"	2	Nothing
28	23	28	"	"	33	"	3	Nothing
29	26	28	two-thirds	"	28	"	1	Nothing
30	35	28	one-third	"	25	"	1	Nothing
31	25	27	one-half	"	31	"	2	Nothing
32	25	24	"	"	25	"	1	Epidermis
33	25	17	"	stom. & int.,	35	"	1	Epidermis
34	27	13	one-half	" "	28	"	1	Epidermis
35	27	12	"	" "	28	"	1	Epidermis, Zygnema, Mougeotia
36	22	10	"	" "	28	"	5	Epidermis
37	24	10	two-thirds	" "	32	"	2	Epidermis, Spirogyra. Zygnema, Vaucheria, Mougeotia, Navicula, Diatoma
38	21	10	"	" "	34	"	5	Epidermis ?
39	24	8	"	" "	28	"	5	Epidermis
40	23	7	"	" "	23	"	1	Epidermis
41	24	7	"	" "	32	"	5	Nothing
42	25	9	large	" "	24	"	5	Epidermis, Spirogyra, Oscillatoria, Diatoma, Synedra
43	27	6	"	" "	28	"	5	Epidermis, egg of Daphia, one of Simocephalus, bit of plant tissue
44	23	6	"	" "	26	"	5	Epidermis
45	23	5	"	" "	33	"	5	Epidermis
46	26	5	"	" "	24	"	1	Epidermis
47	25	5	"	" "	30	"	5	Epidermis
48	21	5	"	" "	24	"	5	Epidermis
49	24	5	"	" "	30	"	5	Epidermis
50	23	5	"	" "	32	"	5	Epidermis
51	24	5	"	" "	30	"	5	Epidermis, mud, Navicula, Eunotia, Gomphonema, Spirogyra
52	23	5	"	" "	34	"	6	Epidermis, Empididæ ? 1
53	29	4	"	" "	42	"	1	Epidermis
54	32	4	"	" "	27	"	5	Epidermis
55	27	4	"	" "	29	"	1	Epidermis
56	25	4	"	" "	26	"	1	Epidermis, egg of Simocephalus, 7 eggs of Daphia, several statoblasts
57	24	4	"	" "	30	"	5	Collembola 1
58	25	4	"	" "	27	"	5	Tipulidæ 1, Achene of Eleocharis acicularis
59	27	4	"	" "	40	"	1	Epidermis, Oribatella 1
60	25	3	"	" "	31	"	1	Epidermis
61	26	3	"	" "	28	"	1	Epidermis, plant fibers
62	26	3	"	" "	28	"	1	Epidermis, Jassidæ 1
63	25	3	"	" "	28	"	1	Epidermis
64	25	2	"	" "	35	"	5	Phoridæ 1, Chironomidæ pupa, Coleoptera larva, Staphylinidæ 1, achene of Eleocharis acicularis
65	25	2	"	" "	33	"	5	Lygæidæ 1, Attidæ 1
66	23	2	"	" "	30	"	1	Jassidæ 1
67	26	2	"	" "	28	"	1	Epidermis, Crustacea egg, Carex seed
68	23	2	"	" "	30	"	5	Nothing
69	23	2	"	" "	30	"	5	Epidermis
70	23	2	"	" "	30	"	5	Epidermis, Phoridæ 1
71	26	2	"	" "		"	6	Epidermis, Lepidoptera larva, Diptera 2 larvæ, Drosophilidæ 1, Carabidæ 1

Table 4. Data for Rana palustris---Continued

No.	Body	Tail	Mouth	Ali. Can.		Fore Legs		Lot	FOOD
72	27	1	"	"	"	35	"	1	Epidermis, Hydrachnidæ 1, Jassidæ 1, Diptera 1, Coleoptera 1, few algal filaments
73	27	1	"	"	"	34	"	1	Epidermis, Staphylinidæ 1
74	25	1	"	"	"	35	"	1	Lygæidæ 1, Nabidæ nymph, Ephydridæ ? 1
75	27	1	"	"	"	32	"	1	Epidermis with Mougeotia, Haltica ? 1
76	24	1	"	"	"	31	"	5	Epidermis, Proctrotrupidæ 1
77	24	1	"	"	"	33	"	6	Epidermis, Drassidæ 2, Chalcididæ 1, Insecta 1
78	26	0	"	"	"	35	"	6	Diptera adult and larva, Pollenia 1, Rhyncophora 1
79	25	0	"	"	"	35	"	6	Phoridæ 1, Coleoptera larva
80	26	0	"	"	"	26	"	6	Epidermis
81	28	0	"	"	"	34	"	6	Lepidoptera larva
82	25	0	"	"	"	35	"	6	Diptera 1, Drosophilidæ 1, Carabidæ 1
83	25	0	"	"	"	32	"	5	Planorbis 1, Heteroptera 1, Staphylinidæ 1
84	27	0	"	"	"	33	"	1	Epidermis, egg of Crustacea, Gamasidæ 1, Mougeotia
85	27	0	"	"	"	33	"	1	Tipulidae 1, Dytiscidæ 1, plant tissue, Ulothrix pieces of chitin
86	27	0	"	"	"	31	"	1	Epidermis, Capsidæ 1
87	25	0	"	"	"	30	"	1	Crustacea egg, Physopoda 1, Collembola 1, Formicidæ
88	27	0	"	"	"	44	"	1	Lymnæa 1, Laccobius 1, sand
89	25	0	"	"	"	33	"	6	Aphididæ 1, Diptera 1, Rhyncophora 1, winged seed
90	26	0	"	"	"	36	"	6	Epidermis, Collembola 1, Chrysomelidæ larva, Braconidæ 1
91	28	0	"	"	"	48	"	6	Insecta larva, seed
92	27	0	"	"	"	50	"	6	Insecta larva, Hydrophilidæ 1
93	26	0	"	"	"	34	"	6	Epidermis, Heteroptera 1, Pollenia 1, Diptera 1
94	27	0	"	"	"	43	"	6	Epidermis, Lymnæa 1, Argiopoidea 2, Jassidæ 1, Diptera 1, Drosophilidæ 1, Staphylinidæ 1
95	28	0	"	"	"	55	"	6	Lymnæa 1, Capsidæ 1, Psilopus 1, Laccobius 1
96	28	0	"	"	"	48	"	1	Daphnia eggs, Liancalus 1, Carabidæ 1, Haliplus 1, Juncus ovary with Lepidop. larva, 2 Carex achenes
97	28	0	"	"	"	50	"	2	Insecta larva, Gryllus 1, Jassidæ 1, Cercopidæ 1, Diptera adult and larva, Tipulidæ 1, Acalyptera 1
98	28	0	"	"	"	40	"	6	Epidermis, Tipulidæ adult and larva, Haliplidæ 1, Proctrotrupidæ 1, small leaf
99	28	0	"	"	"	42	"	1	Helochara (Jassidæ) 3, Tipulidæ 1, Coleoptera 1, Curculionidæ 1, Ephydridæ 1, Chalcididæ 1, Braconidæ 1
100	28	0	"	"	"	40	"	1	Argia nymph, Lygæidæ 1, Rediviolus 1, Helochara 2, Sphærophoria 1, Liancalus 1, Coleoptera larva, Philanthidæ 1, Braconidæ 1

Rana pipiens Schreber. The Meadow- or Leopard-frog.

Total of 100 specimens. Lot 1, Isoetes Ponds, Chicago Bog, McLean, N. Y., July 22, 1916; lot 2, Bool's Backwater, Ithaca, Sept. 1, 1912; lot 3, Taughannock Pond, Ithaca, July 29, 1908; lot 4, Bool's Backwater, Ithaca, Aug. 18, 1906; lot 5, Chicago Ponds, McLean, N. Y., July 30, 1910. Lot 1 collected by Dr. Wright and myself; lot 2, by Dr. Wright; lot 3, by Dr. A. A. Allen; lot 4, by Dr. Wright and Dr. G. H. Sabine; lot 5, by Dr. Wright and Dr. R. G. Gilmore.

Table 5. Data for Rana pipiens

No.	Body	Tail	Mouth	Ali. Can.		Forelegs	Lot	FOOD
1	29	44	tadpole	tadpole,	530	none	1	Mud with Navicula, Diatoma, Synedra, Spirogyra, Oedogonium, Ulothrix, Vaucheria, Anuræa, fibers, moss
2	29	37	"	"	405	"	1	Mud with Cladophora, Navicula, much moss
3	27	37	"	"	210	"	4	Mud with Gomphonema, Cymbella, Navicula, Cocconeis, Cyclotella, Diatoma, Synedra, Meridion, Spirogyra
4	27	36	"	"	360	"	1	Mud with Epithemia, Navicula, Acnanthidium, Vaucheria, pieces of leaves, xylem spirals, broken tissue
5	28	48	changing	stomach,	150	present	4	Mud with Nitzchia, Synedra, Pinnularia, Gomphonema, Cocconeis, Navicula, Cymbella, Meridion, Diatoma, Cyclotella, Closterium, Spirogyra, Oscillatoria, Cypridopsis, plant tissue
6	28	42	"	"	118	"	1	Diatoma, Navicula, Scenedesmus, Mougeotia
7	28	50	"	"	113	"	4	Nothing
8	25	45	small	"	100	"	1	Mud with Navicula, Ulothrix, fibers
9	27	45	"	"	70	"	2	Nothing
10	29	44	"	"	80	"	4	Nothing
11	28	48	"	"	70	"	1	Nothing
12	28	43	"	stom. & int.,	80	"	4	Nothing
13	24	35	"	" "	80	"	1	Mud with Closterium, Pleurococcus, filaments, plant tissue
14	27	38	"	" "	42	"	4	Nothing
15	26	40	"	" "	60	"	4	Nothing
16	27	40	"	" "	58	"	1	Epidermis
17	25	37	"	" "	64	"	1	Nothing
18	26	36	"	" "	45	"	1	Nothing
19	27	35	one-half	" "	37	"	1	Nothing
20	27	34	"	" "	36	"	2	Nothing
21	25	34	"	" "	36	"	2	Epidermis ?, Oscillatoria, Zygnema, Spirogyra, Cladophora, Synedra, Desmidium, Gomphonema, Epithemia, Melosira, mandible of insect larva, shell of bivalve crustacea
22	27	33	"	" "	50	"	1	Nothing
23	28	32	"	" "	50	"	4	Epidermis
24	26	32	"	" "	40	"	2	Epidermis, Zygnema, Synedra
25	27	30	"	" "	30	"	1	Epidermis
26	22	30	"	" "	42	"	1	Nothing
27	23	28	"	" "	45	"	1	Nothing
28	27	28	"	" "	42	"	1	Epidermis
29	28	24	large	" "	40	"	2	Epidermis, Zygnema, Ulothrix, Mougeotia
30	28	22	"	" "	51	"	4	Epidermis
31	27	20	"	" "	38	"	1	Epidermis
32	28	20	"	" "	35	"	1	Epidermis
33	23	20	"	" "	28	"	1	Epidermis
34	22	18	"	" "	32	"	1	Epidermis
35	23	15	"	" "	30	"	1	Epidermis
36	26	15	"	" "	40	"	1	Epidermis
37	21	15	"	" "	28	"	1	Epidermis, small snail ?
38	26	15	"	" "	30	"	1	Epidermis
39	22	14	"	" "	28	"	1	Nothing
40	28	13	"	" "	35	"	1	Epidermis
41	25	12	"	" "	33	"	1	Epidermis
42	27	12	"	" "	42	"	1	Epidermis
43	23	12	"	" "	26	"	1	Epidermis
44	20	12	"	" "	31	"	1	Epidermis
45	25	11	"	" "	33	"	1	Epidermis
46	22	11	"	" "	32	"	1	Epidermis
47	23	10	"	" "	30	"	1	Epidermis
48	28	10	"	" "	37	"	2	Chlorops (Oscinidæ) 1, Muscidæ 1, Culicidæ 1, Heteroptera nymph, Jassidæ 1, Aphididæ 2
49	25	10	"	" "	34	"	1	Epidermis
50	23	9	"	"	29	"	1	Epidermis
51	24	9	"	"	32	"	1	Epidermis
52	27	9	"	" "	30	"	1	Epidermis, Drosophilidæ 1
53	22	9	"	" "	31	"	1	Epidermis
54	25	9	"	" "	30	"	1	Epidermis, egg of Daphnia
55	24	8	"	" "	35	"	1	Epidermis

Table 5. Data for Rana pipiens---Continued

No.	Body	Tail	Mouth	Ali.	Can.	Fore	Legs	Lot	FOOD
56	24	8	"	"	"	30	"	1	Epidermis
57	28	8	"	"	"	46	"	1	Epidermis, Simuliidæ 2
58	23	7	"	"	"	38	"	1	Epidermis
59	27	7	"	"	"	42	"	1	Epidermis
60	20	7	"	"	"	31	"	1	Epidermis
61	37	6	"	"	"	36	"	1	Epidermis
62	24	6	"	"	"	36	"	1	Epidermis, Dytiscidæ 2 larvæ
63	27	6	"	"	"	32	"	1	Epidermis, Dytiscidæ larva
64	27	5	"	"	"	42	"	1	Epidermis, Oribatidæ 3, Collembola 1
65	25	5	"	"	"	31	"	1	Epidermis, Oribatidæ 1
66	28	5	"	"	"	45	"	1	Epidermis, Lymnæa palustris 1, Aphididæ 1
67	28	5	"	"	"	38	"	1	Oribatidæ 1, Collembola 1, Diptera 1, Drosophilidæ 1
68	28	5	"	"	"	31	"	1	Jassidæ 2 nymphs, Aphididæ 2
69	28	5	"	"	"	47	"	1	Mycetophilidæ 2, Phortica 1, Creniphilus 1
70	28	4	"	"	"	47	"	1	Epidermis, Thysanoptera 1, Collembola 1, Aphididæ 1, Dolichopodidæ 1, Simuliidæ 2, Braconidæ 1
71	29	4	"	"	"	44	"	1	Nothing
72	21	4	"	"	"	35	"	1	Epidermis
73	32	4	"	"	"	45	"	2	Braconidæ 1
74	23	4	"	"	"	31	"	3	Epidermis, Staphylinidæ 1, Collembola 1
75	27	3	"	"	"	50	"	1	Lymnæa 3, Muscidæ 1
76	30	3	"	"	"	46	"	1	Epidermis, Collembola 1, Lymnæa 1
77	27	2	"	"	"	45	"	1	Epidermis, Tipulidæ 1, Dytiscidæ 1
78	25	2	"	"	"	40	"	1	Oribatidæ 3, Daphnia eggs, Thysanaptera 2, Collembola 3, Jassidæ 1, Psyllidæ 1, Formicidæ 1
79	25	2	"	"	"	33	"	1	Epidermis, Vermes 1
80	25	0	"	"	"	60	"	5	Heteroptera 1, Homoptera 1, Capsidæ 1, Muscidæ 1, Coleoptera 4
81	25	0	"	"	"	57	"	5	Coleoptera adult and larva, Capsidæ 1, Cercopidæ 1
82	25	0	"	"	"	54	"	5	Heteroptera 1, Diptera 1, Coleoptera 2
83	24	0	"	"	"	58	"	5	Araneida 1, Capsidæ 1, Jassidæ 1, Muscidæ 2, Coleoptera 2, Hymenoptera 1
84	25	0	"	"	"	58	"	5	Coleoptera 2, Carabidæ 1, Formicidæ 1
85	26	0	"	"	"	56	"	5	Diptera 1, Coleoptera 1, Cleridæ 1, Hymenoptera 1
86	26	0	"	"	"	45	"	5	Collembola 1, Lampyridæ 1, Staphylinidæ 1, Hymenoptera
87	29	0	"	"	"	69	"	5	Diptera 1, Coleoptera 1, Chrysomelidæ 1, Hymenoptera 1, Philanthidæ 1
88	28	0	"	"	"	60	"	5	Doryphora 1, Cleridæ 5, unidentifiable 1
89	27	0	"	"	"	55	"	5	Diptera adult and larva, Coleoptera larva, Dytiscidæ 1, Rhyncophora 2, Braconidæ 1
90	29	0	"	"	"	61	"	5	Jassidæ 1, Carabidæ 1, Chrysomelidæ 1, Staphylinidæ
91	27	0	"	"	"	57	"	5	Diptera 1, Coleoptera 1, Muscidæ 1
92	24	0	"	"	"	55	"	5	Oribatidæ 1, Jassidæ 1, Diptera adult and larva, Carabidæ 2, Staphylinidæ 1, Formicidæ 1, Braconidæ
93	23	0	"	"	"	46	"	1	Lymnæa 1, Mycetophilidæ 3, Phoridæ 2
94	23	0	"	"	"	53	"	5	Diptera 1, Coleoptera 2 adults and 1 larva, Chrysomelidæ 2, Proctrotrupidæ 1
95	26	0	"	"	"	55	"	1	Epidermis, Lymnæa 2, Thysonaptera 3, Collembola 1, Capsidæ 1, Diptera 1, Drosophilidæ 1, Coleoptera 1, Hydrophilidæ 2, Chrysomelidæ 1
96	27	0	"	"	"	55	"	5	Epidermis, snail, Carabidæ 1, Drosophilidæ 1, Formicidæ 1
97	25	0	"	"	"	37	"	3	Epidermis, Heteroptera 1, Diptera 1, Carabidæ 1, Rhyncophora 1
98	23	0	"	"	"	34	"	3	Epidermis, Psyllidæ 2, Diptera 1, Coleoptera 1, plant-down
99	20	0	"	"	"	30	"	3	Braconidæ 1
100	23	0	"	"	"	43	"	3	Psyllidæ 1, Diptera 1, Carabidæ 1, Braconidæ 1, 4 pebbles

Hyla crucifer Wied. The Spring Peeper.

Total of 32 specimens. Lot 1, Slaughter House Ponds, Ithaca, June 28, 1911; lot 2, Cross-roads Pond, Ithaca, June 22, 1907; lot 3, Slaughter House Ponds, June 27, 1911; lot 4, Chicago Bog, McLean, N. Y., July 22, 1916; lot 5, pond on shore of Lake Ontario, North Fair Haven, New York, July 30, 1916. Lots 1, 2, 3, by Dr. Wright; lot 4, by Dr. Wright and myself; lot 5, by myself.

Table 6. Data for Hyla crucifier

No.	Body	Tail	Mouth	Ali. Can.		Forelegs	Lot	FOOD
1	11	18	tadpole	tadpole,	66	none	1	Mud with Epithemia, Meridion, Gomphonema, Diatoma, Eunotia, Navicula, Synedra, Zygnema, Mougeotia, Ulothrix, Microspora, Crustacea eggs, plant tissue, Paramœcium
2	12	17	"	"	80	"	2	Mud with Zygnema, Oscillatoria, Microspora, Mougeotia, Scenedesmus, Navicula
3	10	16	"	"	17	"	1	Nothing
4	11	16	changing	stomach,	10	present	2	Nothing
5	11	16	small	"	11	"	1	Nothing
6	10	14	changing	"	11	"	2	Nothing
7	11	13	"	"	12	"	2	Nothing
8	11	15	"	"	13	"	1	Nothing
9	10	14	"	"	13	"	1	Nothing
10	11	11	small	"	12	"	1	Epidermis
11	10	11	"	"	12	"	1	Nothing
12	13	10	"	"	11	"	1	Nothing
13	11	10	"	"	15	"	1	Nothing
14	11	9	"	"	11	"	1	Nothing
15	11	8	"	"	12	"	1	Nothing
16	11	7	"	stom. & int.,	12	"	1	Nothing
17	11	7	"	" "	12	"	1	Epidermis ?
18	12	6	large	" "	13	"	1	Nothing
19	11	6	"	" "	11	"	1	Nothing
20	12	5	"	" "	13	"	3	Nothing
21	11	5	"	" "	12	"	1	Nothing
22	12	5	"	" "	18	"	3	Epidermis
23	12	2	"	" "	14	"	3	Diptera 1
24	14	0	"	" "	24	"	4	Cercopidæ 2, Chalcididæ 1, Ichneumonidæ 1
25	14	0	"	" "	20	"	4	Homoptera 1, Tipulidæ 1
26	14	0	"	" "	22	"	4	Diptera 2, Coleoptera 1, Ichneumonidæ 1
27	14	0	"	" "	23	"	4	Diptera 2, Coleoptera 1, Ichneumonidæ 1
28	11	0	"	" "	14	"	1	Epidermis
29	11	0	"	" "	17	"	1	Diptera 1
30	16	0	"	" "	20	"	5	Diptera 1, Capsidæ 1, Phoridæ 1
31	16	0	"	" "	19	"	5	Diptera 2, Proctrotrupidæ 2
32	15	0	"	" "	25	"	5	Insecta 2, Hymenoptera 1

Hyla versicolor Le Conte. The Common Tree-toad.

Total of 23 specimens. Lot 1, Ithaca, July 20, 1911; lot 2, Ithaca, July 22, 1908; lot 3, Lake Ontario, North Fair Haven; lot 4, Ithaca, July 22, 1907. Lots 1, 2, 4, by Dr. Wright; lot 3, by myself.

Table 7. Data for Hyla versicolor

No.	Body	Tail	Mouth	Ali. Can.		Forelegs	Lot	FOOD
1	20	42	tadpole	tadpole,	170	none	1	Mud with Pleurotænium, Cosmarium, Desmidium, Pediastrum, Scenedesmus, Navicula, Pinnularia, Epithæmia, Anabæna

Table 7. Data for Hyla versicolor---Continued

No.	Body	Tail	Mouth	Ali. Can.			Fore Legs	Lot	FOOD
2	16	22	"	"		170	"	4	Mud with Navicula, Pinnularia, Synedra, Pediastrum, Scenedesmus, Cosmarium, Oscillatoria
3	20	20	"	"		130	"	1	Mud with Pleurotænium, Cosmarium, Desmidium, Pediastrum, Navicula, Pinnularia, Anabæna
4	15	22	changing	stomach,		30	present	2	Nothing
5	14	11	small	"		20	"	2	Nothing
6	18	5	large	"		20	"	3	Epidermis
7	19	2	"	stom. & int.,		24	"	3	Nothing
8	20	2	"	"	"	20	"	3	Epidermis
9	20	4	"	"	"	20	"	3	Epidermis
10	21	0	"	"	"	21	"	3	Insecta 1, Diptera 1, Cleridæ 1
11	20	0	"	"	"	28	"	3	Epidermis, Oribatidæ 1, Diptera 1, Formicidæ 1
12	21	0	"	"	"	23	"	3	Oribatidæ 1, Diptera 1
13	22	0	"	"	"	28	"	3	Psyllidæ 2, Trichoptera 1, Diptera 1, Coleoptera Hymenoptera 1
14	21	0	"	"	"	30	"	3	Insecta 2, larva 1, Nabidæ 2, Diptera 1, Ichneumonidæ 1
15	20	0	"	"	"	25	"	3	Tingitidæ 2, Jassidæ 1, Psyllidæ 3, Diptera 1, Hymenoptera 1, Chalcididæ 1
16	22	0	"	"	"	30	"	3	Insecta 3, Cleridæ 1
17	21	0	"	"	"	42	"	3	Tingitidæ 1, Hymenoptera 1, Apidæ 1, Myrmicidæ
18	21	0	"	"	"	40	"	3	Tingitidæ 17, Psyllidæ 1, Coleoptera 1, Hymenoptera 1, plant down
19	20	0	"	"	"	23	"	1	Epidermis ?
20	20	0	"	"	"	23	"	1	Epidermis
21	20	0	"	"	"	25	"	1	Epidermis
22	20	0	"	"	"	18	"	1	Epidermis
23	19	0	"	"	"	19	"	1	Epidermis

Bufo americanus Holbrook. The Common Toad.

Total of 40 specimens. Lot 1, Dr. Wright and Dr. Reed, Cross-roads Ponds, Ithaca, July 4, 1907; lot 2, Dr. Wright, Bool's Backwater, Ithaca, June 29, 1911; lot 3, same, July 4, 1907.

Table 8. Data for Bufo americanus

No.	Body	Tail	Mouth	Ali. Can.			Forelege	Lot	FOOD
1	11	12	tadpole	tadpole,		110	none	1	Mud with Zygnema, Oscillatoria, Navicula, Pandorina, eggs of Crustacea
2	11	12	"	"		80	"	1	Mud with Oscillatoria, Microspora, Pandorina, Navicula, Pinnularia, eggs of Crustacea
3	10	11	changing	stomach,		30	present	1	Mud
4	9	12	"	"		30	none	1	Mud with Pandorina, Navicula
5	9	12	tadpole	"		25	"	2	Mud with Navicula and plant tissue
6	9	12	changing	"		17	present	1	Nothing
7	9	12	"	"		16	"	2	Mud with Navicula and plant tissue
8	10	13	small	"		15	"	1	Nothing
9	10	11	two-thirds	"		16	"	1	Epidermis ?
10	10	11	small	"		14	"	1	Nothing
11	9	10	one-half	stom. & int.,		20	"	1	Nothing
12	10	9	"	"	"	15	"	1	Nothing
13	9	9	"	"	"	13	"	1	Nothing
14	10	9	"	"	"	13	"	1	Nothing
15	9	7	"	"	"	14	"	1	Nothing
16	10	7	"	"	"	12	"	1	Nothing
17	10	7	"	"	"	10	"	1	Nothing
18	9	7	"	"	"	10	"	2	Nothing
19	8	6	two-thirds	"	"	12	"	2	Epidermis ?
20	9	5	"	"	"	12	"	3	Mud, nothing identifiable
21	8	3	"	"	"	10	"	3	Mud
22	11	2	"	"	"	13	"	3	Nothing identifiable
23	11	2	large	"	"	11	"	3	Nothing identifiable

Table 8. Data for Bufo americanus---Continued

No.	Body	Tail	Mouth	Ali. Can.		Fore Legs		Lot	FOOD
24	10	2	"	"	"	12	"	3	Nothing identifiable
25	9	2	"	"	"	12	"	3	Epidermis
26	10	1	"	"	"	13	"	3	Epidermis
27	10	1	"	"	"	11	"	3	Nothing identifiable
28	10	5	"	"	"	13	"	3	Epidermis ?
29	11	5	"	"	"	13	"	3	Mud with Navicula, masses of Pleurococcus
30	9	0	"	"	"	13	"	2	Physopoda 1, Insecta 1
31	11	5	"	"	"	13	"	3	Pulmonata 1
32	10	0	"	"	"	16	"	3	Epidermis, iptera larva
33	11	0	"	"	"	13	"	3	Collembola 2
34	11	0	"	"	"	12	"	3	Nothing identifiable
35	11	0	"	"	"	12	"	3	Nothing
36	10	"	"	"	"	10	"	3	Epidermis
37	10	0	"	"	"	10	"	3	Epidermis, Diptera 1
38	10	0	"	"	"	11	"	3	Nothing
39	9	0	"	"	"	10	"	3	Nothing
40	10	0	"	"	"	10	"	3	Epidermis

Comparison of Tadpoles of the Various Species.

In the eight species used the tadpoles agree in being for the most part herbivorous. The small mouth is provided with horny jaws and is used largely in nibbling off Algae, bits of moss, and other plants, and in gathering up masses of ooze and mud with the many diatoms and desmids to be found in such situations, and the occasional Protozoa of the *Difflugia* and *Arcella* types.

Very often one sees statements such as made by Miss Dickerson that tadpoles, especially of some species, are very "fond of any animal food available. Thus these tadpoles act as scavengers and dispose of dead fish or dead tadpoles even, that would otherwise become a menace to the living creatures of the pond." These statements might indeed be made by almost anyone who has observed tadpoles to any extent. I remember when a boy of reading that a good way of cleaning a skeleton of a small animal like a mouse was to place it in a pond containing many tadpoles and it would soon be nicely freed from the flesh. Experiment showed this to be more or less true; but although I have studied many tadpoles in the series of forms now being discussed, and although these come from many different ponds, the fact that in no case was such animal matter found, leads me to believe that it is not so important a source of food to the tadpole as is commonly believed.

Since all the tadpoles of the various species are aquatic and therefore in rather uniform conditions, one would not expect their food to vary as much as does that of the transformed individuals. The alimentary canal is invariably very long, in keeping with the herbivorous habits; but almost entirely undifferentiated, no stomach nor large intestine being evident. As long as the tadpole mouth is present the alimentary canal is almost always filled with ooze and silt, a great part of which is inorganic. Since the size of the mouth varies considerably with the species, one would expect it to allow of more variation in food-habit than does any other one factor. I was particularly interested, therefore, to see what the largest animal form taken would be and in which species it would be found. Unfortunately I did not have a very good series of specimens with the tadpole mouth in the large bull-frog and green-frog, but those examined showed almost no variation from the smaller species. One green-frog did have a small crustacean (*Ceriodaphnia?*), a meadow-frog contained a rotifer (Anuræa), another had a crustacean (*Cypridopsis*), and a peeper was found with

many winter eggs of Crustacea. Aside from the few cases of *Euglena, Paramæcium, Difflugia* and *Arcella* met with, almost all of the remaining food was plant. No attempt was made to make any quantitative observations on the plant materials found. In number of individuals and actual amount of substance the diatoms were very important; many desmids, some filamentous algae, and quite large amounts of wood-fibers and tracheids, bits of leaves and other broken down plant tissues were found. This is another bit of evidence in the rather vast amount which has now accumulated to show the great importance of the diatoms in aquatic biology and ecology. Table 9 shows in a relative way the frequency of occurrence of the various forms of food.

TABLE 9

The Frequency With Which the Various Species of Tadpoles Contained the Various Food-forms.

	Bull-frog	Green frog	Wood-frog	Pick-erel frog	Meadow frog	Peeper	Tree-toad	Toad
Specimens opened	3	10	7	4	4	3	3	2
DIATOMS								
Epithemia	1		1	2	1	1	1	
Navicula	2	6	5	4	5	2	3	2
Pinnularia	2	1	1	2			3	1
Diatoma	2	4	2	4	2	1		
Synedra	1	4	1	2	2	1	1	
Nitzchia	1	4	1	2				
Cymbella	2	1	1	1		1		
Meridion	2		2		1	1		
Eunotia		3		2		1		
Gomphonema		3	1	3	1	1		
Miscellaneous	1	2	2		2			
FILAMENTOUS ALGAE								
Zygnema		4		1		2		1
Ulothrix	1				1			
Spirogyra	1	4	1	2	2			
Cladophora		1			1			
Mougeotia		2		2		2		1
Miscellaneous		1	1		3			
BLUE GREEN ALGAE								
Oscillatoria	2	3	2	1		1	1	2
Anabæna		1					2	
OTHER ALGAE								
Closterium		1	1	3	1			
Cosmarium				2			3	
Pediastrum							3	
Desmidium							2	
Pleurotænium ....1..							2	
Scenedesmus			1	4		1	2	
Cocconeis			1		1			
Merismopedia				2				
FLAGELLATA		2	2	1				2
PROTOZOA		1	1			1		
ROTIFERA					1			
CRUSTACEA		1			1			
EGGS OF CRUSTACEA		1				1		2

The figures given in this table indicate the number of stomachs in which the various forms occurred, as no attempt was made to keep a count of the number of times any one form was found in a given stomach.

Comparison of Young Transformed Individuals of the Various Species.

Just a glance given at the data of the transformed individuals of the eight species as presented in the preceding pages, will show in a general way that their food consists largely of insects with some spiders, mites, and other forms, largely as

has been reported for the adults by previous workers. I think it is worth while, however, to go into more detail and to see, for example, whether the young frogs and toads change at once to the more or less terrestrial habits of the adults or whether they feed largely on the aquatic forms at first. Let us see, too, whether they are limited very much by their size as to their range of food, and whether they begin their predaceous habits at once or still feed on the diatoms and algae on which they grew.

Perhaps a table comparing the different species will show most readily what we desire. In Table 10 the animal forms contained in the stomachs examined have been listed, the attempt being made to separate those which are without question aquatic from those probably not taken in water. The Collembola, young Anura, and insect eggs might have been taken on water or not and are classed as doubtful. It is possible, of course, that any of the winged insects might have fallen into water and have been seized as they were struggling or floating on the water, but this could scarcely have been true of many. Anyone who has watched transforming Anura knows that they hop briskly about in the neighborhood of the pond and have every opportunity to catch their prey in the air, from the surface of the mud, or from plants.

TABLE 10

Relative Numbers of Aquatic and Non-aquatic Animal Forms Found in Transformed Individuals.

	Bull-frog	Green frog	Pick-erel frog	Meadow frog	Wood frog	Peeper	Tree toad	Toad
Protozoa	4				1			
Water Snails		8	4	8	4			
Crustacea and eggs	16	1	15	4	1			
Water Mites	1		1		2			
Odonata Nymphs	3	3	1					
Aquatic Hemiptera		2			1			
Chironomid Larvæ		1	1		6			
Aquatic Coleoptera	6	3	5	6	7			
Rana Tadpole	1							
TOTAL AQUATIC FORMS	31	18	27	18	22			
Collembola	19		3	10	37			2
Eggs	2	1						
Young Anura	2							
Doubtful Forms	23	1	3	10	38			2
Vermes		10		1				
Land Snails		2		1				1
Land Crustacea	1	39			1			
Myriapods		3						
Spiders	1	18	5	1	6			
Land Mites	17		2	9	5		2	
*Land Insects	2	4	4	1	4	2	7	1
Adult Odonata	5							
Thrips			1					
Crickets			1					
Land Hemiptera	10	16	21	27	9	4	30	
Scorpion Flies	1							
Psocids	1				12			
Lepidopterous Larvæ	1	2	3		4			
Diptera	6	36	28	35	32	10	6	1
Dipterous Larvæ			5	2	2			1
Coleoptera	21	48	13	41	12	2	4	
Coleopterous Larvæ			4	3	3			
Hymenoptera	6	19	9	18	24	7	17	
TOTAL NON-AQUATIC FORMS	71	200	96	139	113	25	66	5
TOTAL ANIMAL FORMS	125	219	126	167	173	25	66	7
Per Cent Aquatic Forms	25%	8%	21%	11%	13%	0%	0%	0%
Per Cent Doubtful Forms	18%	½%	2%	6%	22%	0%	0%	29%
Per Cent Land Forms	57%	91%	76%	83%	65%	100%	100%	71%
Number of Stomachs	29	40	41	40	40	9	8	5

*Not further identifiable.

It is unfortunate that no more transformed individuals were available for the toad, the per cents recorded for it are probably not worth a great deal; however, the fact that no aquatic forms were found even in the five individuals studied is suggestive and made understandable by the fact that young toads soon leave the ponds by hundreds and at transformation time can be seen traveling toward the higher ground in all directions. The absence of aquatic or even doubtful forms in both species of *Hyla* can probably be substantiated by the examination of larger numbers; for young tree-frogs and peepers climb on plants above the ponds in which their larval life was spent and, sitting on the leaves and branches of *Iris*, of shrubbery, or whatever is available, are ready to catch insects that crawl over the plants or come flying to them.

It is noticeable, too, that the distribution of the forms eaten through many families and orders is not nearly so great for these smaller species as for the species of *Rana*. Dr. Wright[8] has shown that for the Ithacan Anura the average lengths at transformation are as follows:

Bufo americanus	9.6 mm.
Hyla versicolor	16.0 "
Hyla crucifer	11.0 "
Rana pipiens	24.0 "
Rana palustris	24.0 "
Rana sylvatica	16.0 "
Rana clamitans	32.0 "
Rana catesbeiana	53.0 "

The smaller size of some species naturally limits their food somewhat. The habit in both species of *Hyla* of sitting on plants, and their failure to hop about over the ground as do some of the other forms may also have much to do with the explanation of their eating fewer kinds of insects and other invertebrates such as spiders and sow-bugs.

In the genus *Rana* a general tendency toward the habits of the adults is to be observed; although the green-frog is a marked exception. One would expect young bull-frogs to eat a rather large per cent of aquatic forms and the rather low per cents given in Table [illegible] for the wood-frog and meadow-frog are not surprising. But the remarkably low per cent for the green-frog was hardly to be looked for. In this connection a comparison with the data given by Surface[9] for the adult forms may be of interest. His report lists the stomach-contents of 29 bull-frogs, of 107 green-frogs, 28 wood-frogs, 88 pickerel-frogs, 51 meadow-frogs, 17 peepers, 22 tree-toads, and 52 toads. By making a rough estimate of the forms which he lists I find that the comparison with the newly transformed is as follows:

[8] Wright, A. H., 1914. Life-histories of the Anura of Ithaca, New York. Carnegie Institution of Washington.

[9] Surface, H. A., 1913. Economic features of Amphibians of Pennsylvania. Zoological Bull. Pa., Dept. of Agriculture, 3;67-152.

TABLE 11

Percentage of Aquatic Forms Found in the Food of Adults as Compared with Newly Transformed.

	Bull-frog		Green-frog		Wood-frog		Pickerel-frog		Meadow-frog		Peeper		Tree toad		Toad	
Aquatic	25	32	8	6	13	2	21	4	11	7	0	0	0	0	0	0
Doubtful	18	5	½	4	22	0	2	1	6	0	0	0	0	0	29	1
Non-aquatic	57	63	91	90	65	98	76	95	83	93	100	100	100	100	71	99

In this table the figures express per cents, the one given first is for the young, the second being for adult. It will be at once apparent that the bull-frog is by far the most aquatic in feeding-habit, that the green-frog, although a form remaining close to the water, lives very largely on non-aquatic insects, that the peeper, tree-toad, and toad apparently eat practically no aquatic forms from the time that they transform, and that the wood-frog, pickerel-frog, and meadow-frog leave the water more gradually and always do have a small percentage of their food aquatic, although not so much of it is so in the adults as in the young. Of all these species the green-frog is perhaps the most surprising. Drake's[10] results for the meadow-frog, based on the most exhaustive study yet made and showing a total of 931 animals found in 209 stomachs, give about five per cent as being unquestionably aquatic, so that his work agrees very well with the results given above.

Economic Bearing.

The economic application of a piece of work of this sort should be two-fold. As new information is obtained regarding the food-habits of frogs, especially at transformation, their life-history and propagation can be better understood. If frogs are unable to eat at transformation, a fact which I think I have quite thoroughly established, it is useless to feed them at that time. The second point of application that comes to mind is that a study of the food of the newly transformed may show something as to the usefulness of the species in destroying harmful insects, sow-bugs, slugs, and other forms. My data are hardly full enough nor important enough to go into this in detail, but a more extended investigation of the food of the adults is worth while from this standpoint. The results of other workers, such as Kirkland, Surface, and Drake, do show that a great many harmful forms are destroyed. For more detail their writings should be consulted.

Conclusions and Summary.

Eight species of Anura were studied during their transformation to learn something of their food-habits as larvæ, as transforming individuals, and as young frogs or toads. The species studied were as follows:

Rana catesbeiana Shaw.	The Bull-frog.
Rana clamitans Latreille.	The Green-frog.
Rana sylvatica Le Conte.	The Wood-frog.
Rana palustris Le Conte.	The Pickerel-frog.
Rana pipiens Schreber.	The Leopard- or Meadow-frog.
Hyla crucifer Wied.	The Peeper.
Hyla versicolor Le Conte.	The Tree-toad.
Bufo americanus Holbrook.	The Common Toad.

[10]Drake, C. J., 1914. The food of Rana pipiens Shreber. Ohio Naturalist, 14:257-269.

In each species studied the same general tendencies are evident: ((1) The larval alimentary canal is very long, but slightly differentiated in its various portions, and filled with ooze and mud scraped up from objects in the pond and containing many forms of diatoms, blue-green and green algæ of. filamentous and non-filamentous types, small pieces of plant tissue, and bits of fiber and other slowly decaying material to be found in ooze. Very few tadpoles were found with any animal food, the exceptions having a few small Crustacea, Protozoa and Rotifera.

(2) After both pairs of legs are evident and the horny plates of the tadpole mouth are shed, the tail is found to be gradually absorbed and the alimentary canal decreases to about one-tenth of its larval length at the same time that it widens anteriorly to form the stomach and posteriorly to form the large intestine. During this transformation period the mouth increases to about six or seven times its former size and there is practically no feeding done. The epidermis is apparently shed rather frequently as the tail is being absorbed; for its presence in the alimentary canal during the final stages of transformation is so frequent as to be quite universal in the larger species and occurs in all those studied.

(3) After these changes have been just about completed the young frog or toad begins life as a carnivor, apparently taking anything movable yet small enough for it to handle. Occasional bits of plant-down and small feathers testify to the attractiveness of a moving object. Almost all groups of invertebrates and some vertebrates are represented in the diet, the largest per cent being insects, crustaceans, spiders, sowbugs, and snails. Some individuals do contain pieces of plant tissue, sand, mud, and other inactive objects, but these seem to be accidental, often occurring where ground beetles or similar forms have been eaten.

(4) The newly transformed individuals show a decided tendency toward the habits of the adults; the toad, tree-toad, and peeper eating almost nothing of an aquatic nature; the meadow-frog, pickerel-frog, and wood-frog eating some aquatic forms, a few per cent more than do the adults of their species; of the other two species, both of which are considered quite aquatic in habit, the green-frog has about nine-tenths of its food non-aquatic and the bull-frog about three-fourths non-aquatic.

By way of summary, then, the tadpoles of the species of Anura studied for this paper are largely herbivorous, the transforming individuals do almost no feeding, and the young frogs or toads are mostly carnivorous. These changes in habit are made possible by great changes in the alimentary canal and mouth.

The Central Nervous System of Three Bivalves

WILLIAM A. HILTON

Lima Deliscens.

The central nervous system forms a rather compact mass of nervous tissue, with certain special local thickenings where nerve cells are abundant. As in Pectin, as described by Drew, the visceral ganglion is the largest, but it is not so widely separated from the other ganglia as in Pectin. Neither is it so complicated in structure.

There are, on each side, three main branches from the visceral ganglion, the most caudal goes over the adductor muscle to the mantle. The next, the smallest main branch, goes to the gills, while the last branch, the largest, is chiefly a mantle branch, which divides after leaving the ganglion.

The cerebro-pleural ganglia are connected medio-caudally by a looped commissure, the other large medial branch on each side runs to the rather large pedal ganglion, while near it is the small otocystic branch, much as in Pectin. The large, more cephalic branch runs towards the mouth region and gives off a number of branches, about seven.

The pedal ganglion is made up of two nearly distinct parts and from each of these lateral parts a branch runs into the foot.

The visceral ganglion is more complex than the others in structure, but there are only a few distinct fiber tracts.

In all the ganglia, the cells are large or ganglionic and small or ordinary nerve cells.

Sunset Clam, *Psammobia californica*

The cerebral ganglia are of fair size and not widely separated. There is a cephalic branch supplying the mouth region and palps and a more ventral branch also on each side, supplies neighboring parts. The commissure between the two ganglia is rather narrow considering the size of these centers.

The Pedal ganglion is small and gives little indication of being divided into two parts. The two connectives come to it and two rather large branches leave.

The visceral ganglion is large and especially well developed. This is because of the large siphons and their necessary abundant nerve supply. The siphons are capable of being extended some distance from the shell. The ganglion is complexly lobed on superficial view. There are on each half at least six little lobes which represent to some degree groups of nerve cells. On each side in addition to the large connective branch there are branches as follows: (1) a large branch to the gills, (2) a large trunk which divides again into mantle branches. One of its branches going to the dorsal siphon, (3) a small dorsal branch, (4) a small ventral branch, (5) another large mantle branch which sends some strands to the ventral siphon, (6) another large mantle branch, (7) a small branch to the posterior adductor muscle.

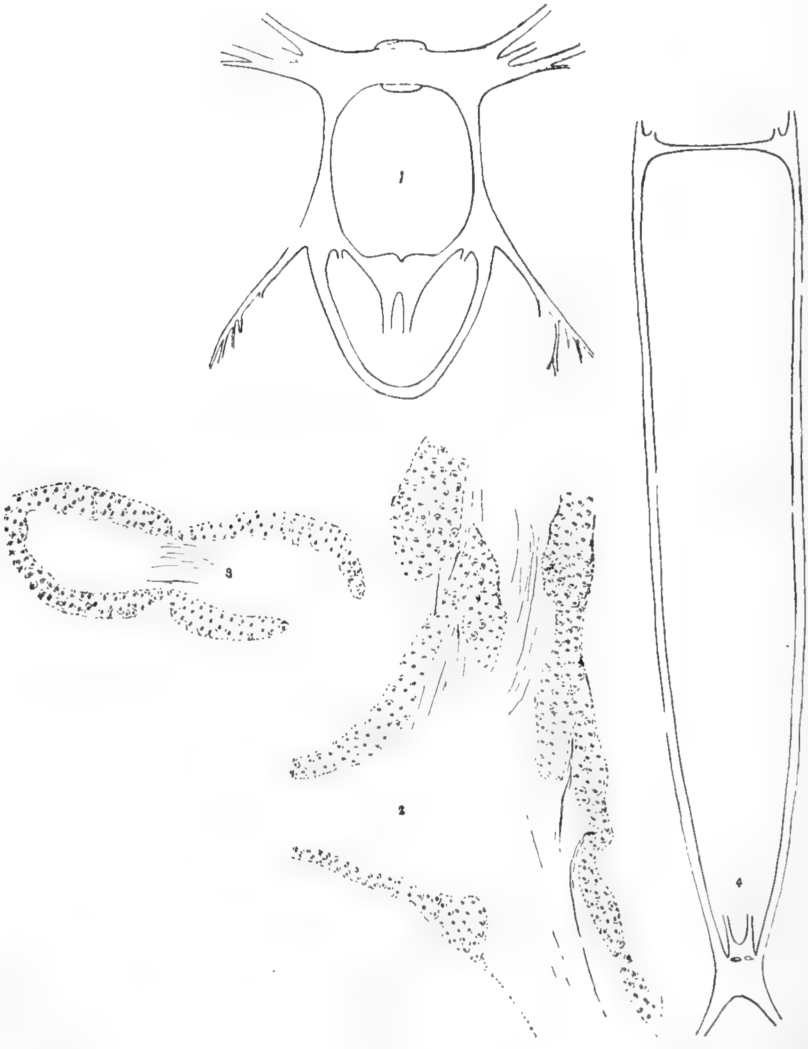

Fig. 1. Central ganglia of Lima X9.

Fig. 2. Section of Cerebral ganglion X70.

Fig. 3. Section of Pedal ganglion X70.

Fig. 4. Chief ganglia of Piddock X9.

Sections were made of the ganglia. The cerebral ganglia were found to be more complex than those of some other bivalves. This was shown in the differences in cell groups and greater complexity of the central fiber masses. The individual cells differ greatly in size, but they average somewhat larger than in some other bivalve forms studied.

The pedal ganglion, although not so complex, also shows differences between cells. There are large multipolar cells and among these are small ones of various sizes. The processes of the larger cells may be traced into the fibrous mass for some distance.

The visceral ganglion is composed of two large lateral parts closely fused. There are numerous commissural bands binding the two sides, but the chief fusion is by more or less individual fibers. Cells inclose the whole ganglion and as in the other centers they are of large and small size. The cell areas of the larger cells are mostly localized on the dorsal and upper surfaces, but the lower end of the ganglion has some large cells. The large cells are especially found in the neighborhood of the larger branches, those branches supplying the mantle and siphons and it seems that some of the larger cells are concerned with supplying these characteristic parts.

The California Piddock, *Parapholas californica Conr.*

The ganglia were dissected in medium sized individuals. The cerebral ganglia are about as in other bivalves. The ganglia are quite widely separated. Besides the commissures connecting them and connectives to lower ganglia there are several branches to the mouth region from the upper and lateral sides.

The visceral ganglion forms a larger mass than any other of the ganglia. There is very little indication of right and left halves. Closely joined to it is the small pedal ganglion.

Microscopic examination of serial sections bring out further details.

The cerebral ganglion is simple in structure. There are a large number of cells in proportion to the fibres in the center of the ganglia. As in many other molluscs, there are many small cells and a few much larger ones, but these last are not abundant. In the large cells it is not difficult to determine fine fibrils and strands from the smaller cells near by. There is also a very complex mingling of strands from the central fibrous mass. Some of the fibers are small, some are larger. The appearance of these larger cells is much as described by Apathy. The cells in the ganglion are chiefly multipolar.

The visceral ganglion is the largest and most complicated. Caudally it sends two thick nerves backwards. These are its chief branches for a long distance; they do not branch. The two sides of the ganglion are joined by many cross fibers and there a few bundles in distinct commissures. Most of the cells are small, but there are a few of the larger type. The cells form a rather uniform sheath all about the ganglion, but here and there we find special cell areas. The fibers are much less evenly disposed and present a very complex mat in every part.

The large cells in some cases have a symmetrical distribution. There are certain individual lateral cells of this sort, also some dorso-central ones which seem to occupy

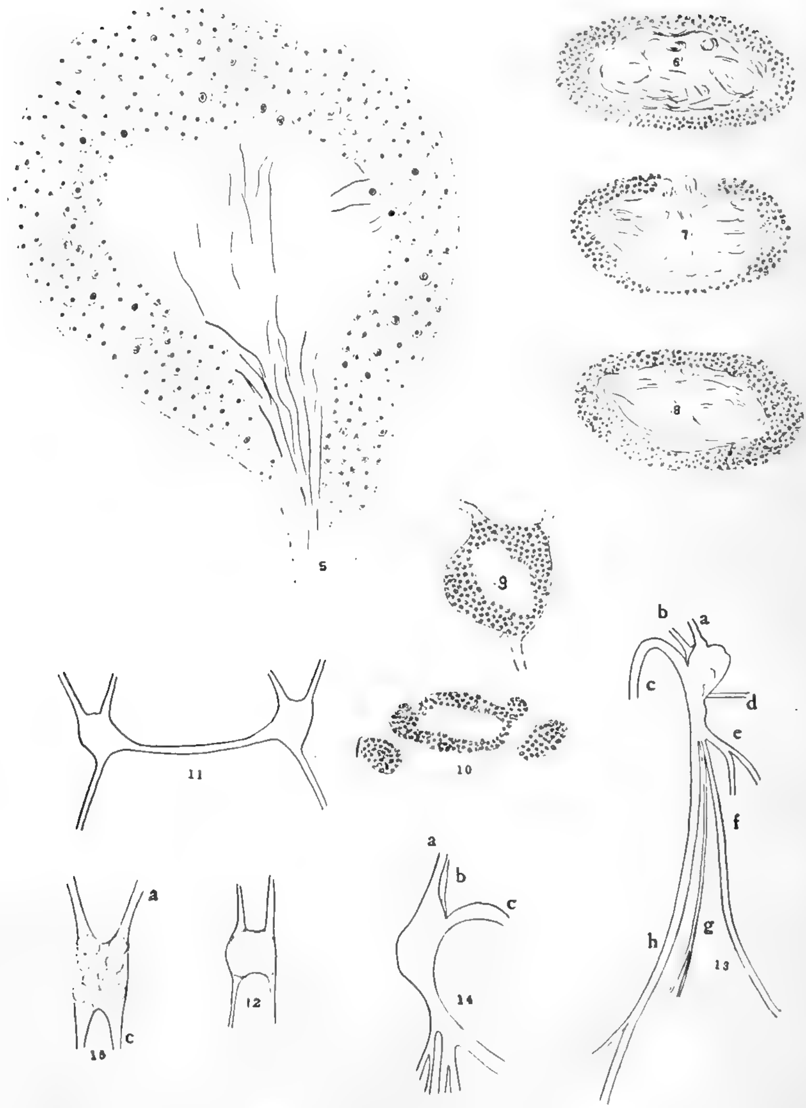

Fig. 11. Cerebral ganglia. X9. Sunset clam.

Fig. 12. Pedal ganglion. X9. Sunset clam.

Fig. 13. Visceral ganglion from the side. (a) Connective branch, (b) dorsal branch, (c) gill branch, (d) branch to posterior adductor muscle, (e) mantle branch, (f) mantle and ventral siphon branch, (g) small mantle branch ?, (h) mantle and dorsal siphon branch. Sunset clam.

Figs. 14 and 15. Other views of the visceral ganglion, lettering as in Fig. 3. X9.

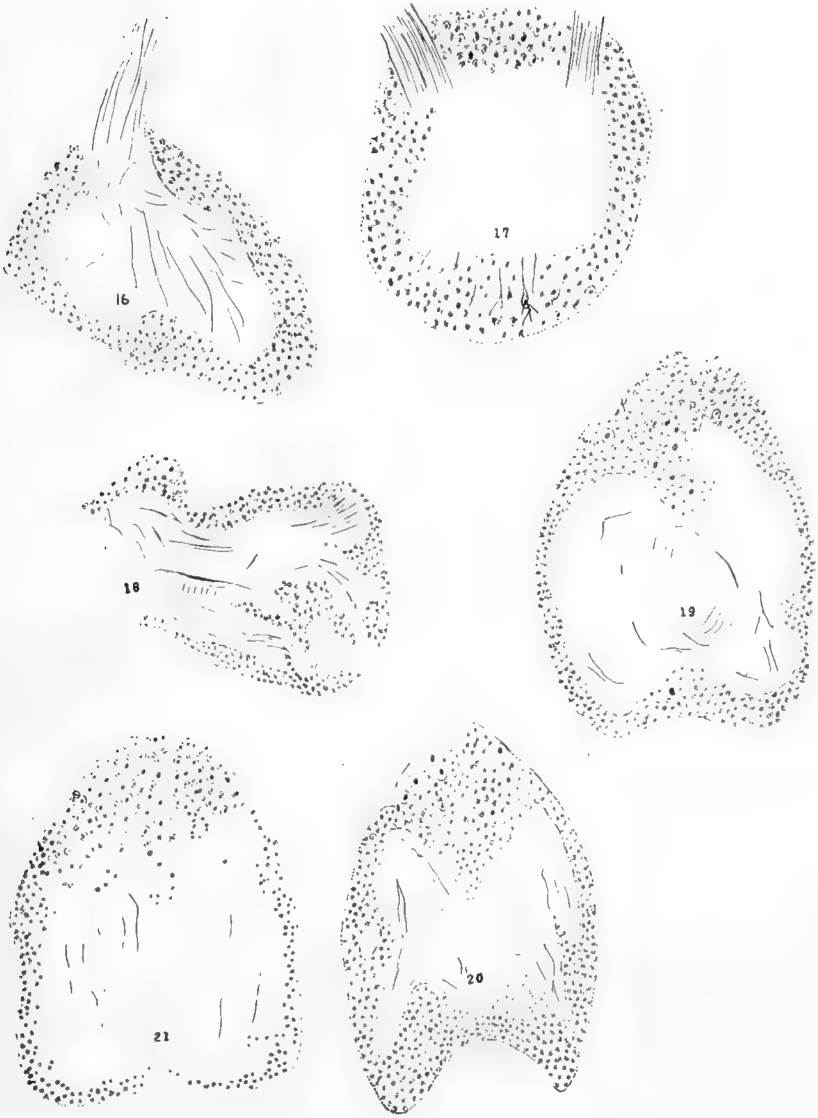

Fig. 16. Cerebral ganglion, section. The commissure shows. X70. Sunset clam.

Fig. 17. Longitudinal section of a pedal ganglion. X70. Sunset clam.

Figs. 18, 19, 20, 21. Various sections of visceral ganglion. The dorsal side is up. X70. Sunset clam.

characteristic positions. Also on the dorsal side there are two peculiar fiber masses in symmetrical positions.

The pedal ganglion is small and just in front of the visceral. It is almost a part of the visceral and closely applied to it. It has two chief nerves on the cephalic side. Its central fibrous mass is slight.

Explanation of Figures.

Fig. 4. Chief ganglia of Piddock. The cerebral ganglia are above, the visceral mass with the small pedal ganglion attached below. X9.

Fig. 5. One cerebral ganglion with part of the connective. X350.

Fig. 6. One cerebral ganglion, a branch above, the connective to the left, the commissure branch to the right. X70.

Figs. 7, 8 and 9. Sections through three levels of the visceral ganglion. The dorsal side is up. X70.

Fig. 10. Section through the pedal ganglion with the two connectives as isolated pieces each side. The dorsal side is up. X70.

A List and Some Notes on the Lizards and Snakes Represented in the Pomona College Museum

Raymond B. Cowles

The purpose of this article is to give a general idea as to the distribution of snakes and lizards from the desert regions of Southern California, with a few observations on their habits. It is also an enumeration of the snakes and lizards which may be met with in the region about Claremont.

The list has been compiled from specimens in the Pomona College Museum only, and the writer is well aware that not all the specimens from the Claremont and desert regions are represented. No effort is made to give the limits of the range of the specimens nor to give any conclusions as final. In those cases where a list is given of the places from which specimens were taken, it is merely to show that the range is at least of that extent.

Testudo agassizi (Cooper).

One of these desert tortoise was taken at Ludlow, California, towards the last of April, 1920. It was found out in the open at the base of an alluvial fan, and made no effort to escape capture. It is being kept alive with a view to study its habits so far as possible under artificial conditions.

Dipsosaurus dorsalis (Baird and Girard).

Taken from fifteen miles east of Blythe Junction, April 2, 1920, in the sand hills. A second specimen was taken 45 miles west of Blythe, in a sand wash, on April 4, 1920.

The main habitat of this lizard seems to be the sand hills or sandy country, and it takes refuge in the holes of rats when menaced.

During August of 1919 they were seen in pairs and seemed to be breeding. Observations seemed to show that a given pair occupied the same territory and rarely traveled far from it. They were seen most on the hottest days, feeding on the leaves of some of the low desert shrubs. Upon being frightned they would drop from the branches and run rapidly, with the entire body raised from the ground, to the nearest burrow, where they would remain for half an hour or more before reappearing. On cloudy days, even though the temperature remained above 100° F. they were seldom seen and appeared to be very sluggish, sometimes allowing one to approach to within a few feet of them before running.

Their food seemed to be almost exclusively plants, and they preferred the leaves of an alfalfa plant which happened to be growing near their chosen range. During an entire summer, June 25 until September 25, they were seen eating insects only once. The specimen eating the insect escaped and it is not know what insect it might be, though from a distance it appeared to be one of the Acrididae.

Uma notata (Baird).

Only one specimen of this beautiful lizard is found in the museum, and it was taken in the sand hills 15 miles east of Blythe Junction, April 2, 1920. The lizard is very shy, running rapidly to the shelter of a burrow in the sand, at the least threat of danger. (This seems to be between *U. notata and U. scoparia.*)

Calisaurus ventralis ventralis (Hallowell).

This lizard appears to be one of the most numerous and widely distributed of the Colorado and Mojave deserts, having been found in almost every type of country with the exception of the rocky hills and mountains, from Victorville to Needles and south to the Mexican Border in Imperial Valley. In the Providence Mountains they were found at an altitude of over a thousand feet.

In the Imperial Valley they were found to burrow, or push down into the sand at the approach of night. Here they remained until sunrise of the next day. At the approach of danger they jump from the sand with such suddenness as to give the impression of a small explosion.

The distribution as given above is not intended as a limit to their range but merely a note on their presence in those places.

Crotaphytus collaris baileyi (Stejneger).

This lizard is represented by three specimens in the college collection. One taken from near the Bonanza King Mine, Providence Mountains, March 31, 1920; another from the N. E. spur of the Turtle Mountains, and a second and smaller one from the same place, April 1, 1920.

These lizards were found on the rocky hill-sides and were very active and rather shy. Their strong jaws and great speed fit them for the predaceous life which they lead. In the largest specimen was found an eight inch *Cnemidophorus tigris tigris,* partially digested.

Crotaphytus wizlizenii (Baird and Girard).

Two specimens were taken at the grass fields between Blythe and Mecca, on April 2, 1920.

These specimens were found skulking under the branches of the creosote bushes. They are very rapid runners, and are predaceous. Their coloring blends admirably into the mottled shade where they lie in wait for their prey. A ten-inch *Cnemidophorus tigris tigris* was taken from an eleven inch specimen. Their biting ability was well proved upon the collector who picked up one of the specimens which had been only wounded. One bite tore through the skin of the first finger, causing a decided flow of blood.

Sauromalus ater (Dumeril).

One specimen taken in the lava rocks east of Ludlow, March 30, 1920. Two specimens taken among the rocks in the N. E. spur of the Turtle Mountains.

These lizards, which are not fast runners, are usually found near some crevice in the rocks in which they take refuge upon the approach of danger.

The two specimens taken in the Turtle Mountains, April 1, 1920, were found as a pair, and when first seen appeared to be in copula. This gives some suggestion as to the time of breeding.

Uta Stansburiana elegans (Yarrow).

Several specimens were taken during the first week in April, and they seem to be farily common throughout a large part of the Mojave and Colorado deserts, in California at least.

Sceloporus magister (Hallowell).

One specimen taken 35 miles east of Mecca, California, April 2, 1920. Other specimens taken during July and August, east of Holtville, California. These lizards seem to prefer the brushy country or the neighborhood of trees, into which they climb when frightened. The specimen taken east of Mecca was found on the ground beneath a cactus.

Phyrnosoma platyrhinos (Girard).

Representatives from five miles west of Amboy and Needles, California. Without an exception they were found on the dry gravelly washes or in the sand not far from washes.

Xantusia vigilis (Baird).

Three specimens from east of Victorville, and one from the Providence Mountains, near Bonanza King Mine, March 30, 1920. These specimens were all found beneath the bark of prostrate yuccas.

Cnemidophorus tigris tigris (Baird and Girard).

These lizards appear to be one of the most common found on the Colorado and Mojave deserts in California. Their range is extremely varied, specimens being taken from, and between, Victorville, Needles, Blythe, the Mexican border in Imperial Valley, and Palm Canyon. These localities are not given as the limits of the range but places within the range from which we have specimens. Specimens were taken in the Salton Sink 265 feet below sea level, and from the Providence Mountains at an approximate altitude of 2,800 feet above sea level.

Sonora occipitalis (Hallowell).

One specimen taken at the grass-fields, between Blythe and Mecca, California. When taken it was traveling out in the open and in the heat of the noon sun, April 3, 1920. It was found on a gravel wash and when approached it struck in all directions, though apparently it did not open its mouth upon striking the hand. It appeared to be blinded by the sun and unable to tell from which direction it was menaced.

Bascanion flagellum frenatum.

Two specimens, both taken near Mecca, Imperial Valley, April 4, 1920. Both these specimens were somewhat lighter than specimens taken from the region around Claremont, California.

One of these snakes was obtained under rather unusual circumstances, which incidentally involved the collecting of a *Cnemidophorus tigris tigris*. The lizard was shot but not killed by the collector, and while watching for an opportunity to kill the lizard without the use of a second shot, the snake was seen gliding in the same direction as the lizard, and suddenly attacked and seized it, when both were added to the collection.

Crotalus mitchelli (Cope).

This specimen was collected by Dr. Hilton and Dr. Munz of Pomona College, at Forest Home, San Bernardino Mountains, June 7, 1919.

Crotalus cerastes (Hallowell).

One specimen taken at Needles, California, April 1, 1920. These snakes seem to be almost entirely restricted to the sandy areas of the desert, rarely wandering from them, and then only for a short distance, its mode of locomotion admirably fits it for the type of country which it inhabits. The ordinary snake finds difficulty in rapid motion over the loose and shifting sand, since part of the tractive power comes from a bracing of each loop of the body against that part of the ground which is posterior to the loop, and through the movement of the central portion of the body against the surface of the ground. It can readily be seen that a shifting and loose surface would seriously hinder the progress of the ordinary snake. The "Side-winder," *Crotalus cerastes,* instead of progressing as do ordinary snakes, longitudinally, progresses laterally, leaving separate tracks, each paralleling the other, and angling in the direction in which the snake is moving. Each track is approximately the length of the snake making it, and is wavy, that is, a series of "S" shaped loops. The tracks give no sign of any part of the body moving from one mark to the other, which gives the impression that the snake jumps the 3 to 6 inch interval between the tracks. Such is not the case, however. When the snake is moving, the body is kept partially looped and the advance seems to be through the advancing of the head and tail, while the rest of the body is rested on the intervening loop, supporting the rest of the body, the weight then seems to be shifted to the head and tail and the rest of the body advanced, the whole progression being a series of graceful and continuous movements. This *seems* to be the mode of progression.

Crotalus atrox (Baird and Girard).

Taken at Mecca, California, April 4, 1920. Found in the arrow weed where it seemed to be fairly common.

In addition to the above list of specimens from the desert region there remain that from the vicinity of Claremont, California, which is as follows: *Uta stansburiana hesperis,* Richardson; *Sceloporus occidentalis bi-seriatus,* Hallowell; *Phrynosoma blainvillii blainvillii,* Gray; *Gerrhonotus scincicauda webbii,* Baird; *Anniella pulchra pulchra,* Gray; *Anniella pluchra nigra,* Fisher(doubtful location. Specimen not labeled. Another from Laguna Beach August 1, 1920) ; *Cnemidophorus tigris stejnegeri,* Van Denburgh; *Plestiodon skiltonianum,* Baird and Girard; *Lichanura roseofusca,* Cope (two taken from vicinity of Claremont and one from east of Victorville by W. M. Pierce) ; *Thamnophis ordinoides hamondii,* Kennicott; *Diadophis amabilis,* Baird and Girard; *Lampropeltis pyromelana multicincta,* Yarrow; *Lampropeltis boylii,* Baird and Girard; *Rhinocheilus lecontei,* Baird and Girard; *Hypsiglena ochrorhynchus,* Cope; *Salvadora hexalepis,* Cope (taken in Imperial Valley 10 miles east of Holtville) ; *Coluber constrictor vetustus,* Baird and Girard; *Coluber flagellum frenatus,* Stejneger; *Coluber lateralis,* Hallowell; *Pituophis catenifer catenifer,* Blainville; *Crotalus oreganus,* Holbrook.

The Central Nervous System of an Unknown Species of Marine Leach

WILLIAM A. HILTON

The little animals from which this study was made were obtained during the summer of 1920 at Laguna Beach. Two times when a number of *Mysis* shrimps were brought in with towings these worms were found attached by the posterior sucker to the side of the crustacean. At first it was not clear to which group of animals these small creatures belonged. It was not until a number of the specimens had been cut in series that their nature was learned. Externally they seemed unsegmented, although the body had many circular rings when contracted by reagents, but these rings were evidently not marks of segmentation. Internally at first there also seemed to be little trace of metamerism, but when the nervous system was examined a clearly defined chain of ganglia was evident.

The mouth is at the base of the large anterior sucker, and it is back of this that the ganglia may be seen. The chief ganglion is the suboesophageal composed of about four parts fused and closely applied to the next ganglion below. The brain or supraoesophageal ganglion is unimportant; in fact, it is the smallest of all. There are sixteen sinmple ganglia forming the ventral chain back of the subœsophageal and the seventeenth ganglion or last of the chain. The last center, or the seventeenth, is made up of at least three simple ganglia fused and is the second most important center. It supplies the structures of the large posterior sucker.

Some of the points of special interest in the nervous system of this creature are:

1. Lack of true metamerism except in the nervous system.

2. The large number of simple clearly defined nerve centers. About four centers are represented in the suboesophageal, sixteen separate ganglia and at least three separate centers for the last ganglion. In all then there are at last twenty-three centers in the nervous system.

3. The small size of the supraoesophageal ganglion or brain.

4. The large size of the subœsophageal ganglion and the last ganglion.

5. No special sense organs were located.

The specimens were from 4-8 mm. in length and, although small, were sexually mature. The identity of the species will be considered at another time.

(Contribution from the Zoological Laboratory of Pomona College.)

EXPLANATION OF FIGURES

Below, the general position of the ganglia is shown. On the left above is an enlarged longitudinal section of the upper ganglia and just below it a cross-section through the brain and subœsophageal with the œsophagus in the space between. The two upper central figures are longitudinal and cross-sections of about the tenth ganglion. The last figure to the left is a longitudinal section of the last ganglion. The dorsal side is up in all the figures. The sections are all enlarged 170 times, the figure of the whole animal is enlarged 20 times.

Central Nervous System of a Centipede

ARTHUR S. CAMPBELL

The central nervous system of *S. Polymorpha* Woods, is especially studied in the present paper.

Hymonds (1898) considers the development giving especial note to the homologies of this system. Newport (1843) gives some notes in regard to the brain. Saint-Remy (1890) gives considerable detail especially in regard to the finer structure of the brain of *S. Morsitans L.* Case (1920) has shown something of the behavior of *S. Polymopha* and indirectly the arrangement of never tracts.

Ordinary dissections and the occaasional use of a binocular microscope proved the most useful.

Successful stains were Heidenh~~eim~~ain's and Delafield's Haem~~to~~atoxylins. $HgCl_2$ or $AgNO_3$ seemed the best fixers. Tracheae were studied without reagents immediately after exposure.

In *S. Polymorpha* the supraoesophagal ganglion or brain comprises three paired, fused divisions or lobes. Large branches extend from the antennal lobes into the antennae. The ocular lobe fuses with this and is distinctly larger and less markedly bilobate. This lobe sends out nerves to the oceili. The labro-fontal division is underneath the ocular lobe and entirely fused with it. It innervates the labrum.

The supraoesophageal ganglion in *S. Polymorpha* is large. It is anteriorally connected with the brain by two circumoral connectives. Ten principal, paried nerves are connected with this ganglion. The anterior pair extend into the mandibles. The second pair supplies the first maxillae, the third runs to the second maxillae. The fourth pair innervates the maxillipeds. The fifth pair supplies the prehensorial feet.

The remaining somites are supplied by simple, similar ganglia, equally spaced but well separated by connectives. The third and fourth ganglia area almost fused, due to the foreshortened segments in which they are located. There is no histological difference between them and other abdominal ganglia. One ganglion only is present in each somite. Altogether in *S. Polymorpha* there are twenty-four ganglia.

Each abdominal ganglion gives off eight nerves. There is no ventral nerve. The first pair of branches supplies the tergular muscles, the second the walking legs, the third the sternal muscles and the fourth supplies the spiracles and tracheae.

The two caudal ganglia present special interest. Four principal branches run from the first of these. The first supplies the tergal muscles, the second the sternal muscles while the fourth supplies the anal legs. Additionally, two preanal connectives join with a small ganglia about half the normal size of the others. Four nerves extend from this last small ganglion into the sphincter and other anal muscles.

In general the superficial tracheal distribution is rather definite and much resembles that of the insects. The brain is rather poorly supplied by but two main tracheae on either side which break up into a number of tracheoles which run into the antennae and optic lobes. In contrast to this, the suboesophageal ganglion is supplied dorsally by three tracheaae on each side.

The abdominal ganglia are each supplied by two ventral tracheae. The dorsal tracheae send vessels throughout the length of the branches on the dorsum of the ganglion. Each ganglion is well supplied by numerous small tracheoles.

The two candal ganglia present some differences in the distribution of tracheal elements. The dorsal surfaces of the twenty-third and twenty-fourth ganglia is supplied by six tracheae. Ventrally there is one principal branch suppling both by numerous tracheoles.

Histologically the brain and other ganglia resemble much those of the more generalized insects. I have found little difference in my specimens and those figured by Saint-Remy (1890) of *S. Morsitans.* The cellular masses of all my preparations seem much less than those figured by Saint-Remy. The fibrous area of the brain contains some indication of lobular masses. There are at least two sizes of cells noticeable.

In the abdominal ganglia the fibrous mass occupies rather more than half the bulk. The cellular area, composed of several sizes of cells, is closely crowded.

The caudal ganglia contain less bulk of the fibrous mass and a large area of cells. The cells here seem to be all of approximately the same size and type.

In all preparations, the nuclei appear large, the nucleoli show prominently. Tigroid substances was noticed in a few of the larger, better stained cells, especially in the brain. Fibrils were seen to enter into certain cells, and touch the nuclei.

CONCLUSIONS

1. The central nervous system of *S. Polymorpha* is composed of twenty-four generalized ganglia. The brain is less complex than that of the insects.

2. Of the three primitive elements of the brain two only are externally apparent.

3. Tracheae supplying the central nervous system are definitely arranged.

4. The functional cells of the central nervous system are of several sizes, the fibrous mass makes up the greater bulk of the ganglion. The cellular area is external and relatively less abundant.

5. Nuclei are large, nucleoli are well marked. Fibrils appear to come into contact with nuclei.

BIBLIOGRAPHY

Case, S.: General Reactions of a Centipede. 1920
Journal of Entomology and Zoology.

Heymonds: 1898
Zur Entwicklungsgeschichte der Chilopoden.
Sitzungslier K. press. Akad. Wissenschaft.

——————: 1901
Die Entwicklungsgeschichte der Scolopender.
Zoologia, Heft. 33.

Newport, George: 1843
Structure, Relations and Development of the Nervous and Circulatory Systems - - - in Myriopoda and Macrourous Arachnida.
Philos. Transactions of the Royal Society.

Saint-Remy, G: 1890
Contributions à l'étude du cerveau chez les Arthropodes Trachéates.
Archiv. Zool. Expér. Tome V. suppl. 1887-90.

(Contribution from the Zoological Laboratory of Pomona College.)

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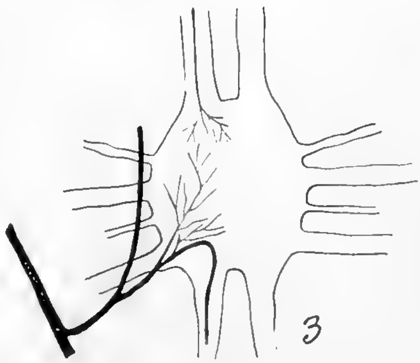

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Fig. 1. Brain and subœsophageal ganglion; tracheæ black. X6.

Fig. 2. Twenty-third and fourth ganglion. X5.

Fig. 3. Abdominal ganglion. X5.

Microscopic Studies of the Water of the Claremont-Laguna Region

GENEVEIVE CORWIN

The climatic conditions in Southern California where these studies were made, are unusual in that the rainy season occurs during the winter and early spring and there is practically no rainfall for the rest of the year. About 10 to 15 inches is the average yearly amount. With this small amount of precipitation, most of the streams dry up completely and the permanent pools diminish in size. This fact has a profound effect upon the life contained in the water. Just how this effect works out has not been determined. Some forms are able to dry up and still retain life, while others are killed by lack of moisture. Almost all the studies recorded in this paper were made on permanent pools and streams.

Studies of the microscopic life of the Claremont-Laguna region were made in the early spring and summer, those of the Claremont region in February, March and April; and of the Laguna region during the last half of June and the month of July of the previous year.

Considering the two places as a whole, in general there were more green algae than blue-green; more algae than Protozoa, the amoeboid Protozoa being fewest in number; the flagellate a little more numerous and the ciliate most frequent, both in species and individuals. The rotifers were rather rare, but were quite varied in form, from the simply constructed, active *Colurus* to the beautifully ciliated fixed *Floscularia.* The *Gastrotricha* were very rare.

The chief difference between the Caremont and the Laguna regions is the abundance of aquatic life. This might be caused by the fact that most of the pools studied around the Laguna were close to the shore and the water may have been brackish. As a rule they were more stagnant than the Claremont water, with the exception of the Laguna Lakes. Perhaps the seasonal change may have had something to do with this difference. The Claremont studies were made over a period of time twice as long as the other and much earlier in the season. However this may be, in almost every group there were more species in the Claremont region than the Laguna and in all other cases there were at least as many, with the one exception of the one desmid found in Claremont and not in Laguna. To summarize the comparison: There were twice as many species of algæ in the Clarement region as the Laguna; the same number of blue-green for both localitis but four times as many green in Clarement. The diatoms were quite numerous and varied in form in both places but there were only half as many species in Laguna. As mentioned before, one desmid was found in Clarement and none in Laguna.

The Protozoa were quite abundant in both regions, there being three times as many in Claremont as in Laguna. In Claremont the amoeboid were twice as numerous as at Laguna. There was a larger proportion of beautiful complicated forms in the Claremont region. There were three species of *Stentor* in Claremont and only two in Laguna. The restless little *Euplotes,* the graceful *Spirostomium,* the beautiful *Stylonychia* are illustrations of the variety of ciliates in Claremont.

There were one-half more rotifers in Claremont than Laguna. However, Laguna had in comparative abundance the very interesting form, *Rotifer neptunis.* This form is quite long and slender when extended, with two rosettes of cilia and a quite unmistakable Neptune's trident at the end of the tail. It is very collapsable, telescoping down to one-third of its extended length. This was peculiar to the smaller Laguna Lake.

Claremont showed several specimens of *Brachionus.* I am not certain of the species but the name must stand for want of a better one. It was a large form with two magnificent wheels of cilia and two short slender arms, each bearing a tuft of cila. When the animal drew in the wheels of cilia at least one of these arms remained exposed. It was rather sedentary, fastening its two small toes to a piece of algae and bending its flexible, stout body in different directions to search for food.

Only one *Gastrotricha* was found in the Claremont region while this same genus *(Chaetonotus)* was found in two different places and more than one individual was seen.

Microscopic Crustacea were rather rare, only one *(Cyclops)* being found in the Sulphur Spring at Laguna. Three other kinds were found in the Claremont region, two in the South Hills, the other at Puddingstone Canyon and in the Puente Hills.

One water mite was found in Claremont in a temporary pool and in no other place.

The comparison between the temporary and permanent pools is not adequate on account of the scarcity of data. In a general way, there is a smaller variety and number of forms in the temporary than in the permanent pools. Streams and permanent pools are similar in the amount of life they contain.

Preliminary List of Microscopic Life in Fresh Water Pools Around Laguna Beach

I. Algae

- A. Blue-green
  - 1. Oscillatoria: found in
    - Algae Pool
    - Smallest Laguna Lake
    - Largest Laguna Lake
  - 2. Spirulina
    - Smallest Laguna Lake
    - Largest Laguna Lake
    - Algae Pool
    - Laguna Canyon Pool
  - 3. Nostoc
    - Smallest Laguna Pool
    - Algae Pool
    - Laguna Canyon Pool
  - 4. Nodularia
    - Laguna Slough
  - 5. Phormidium
    - Smallest Laguna Lake
- B. Green
  - 1. Cladophora
    - Salt Spring
  - 2. Synedra
    - Laguna Canyon
    - Smallest Laguna Lake
  - 3. Ankistrodesmus
    - Algae Pool
    - Laguna Slough
  - 4. Spirogyra
    - Laguna Canyon Pool
    - Laguna Slough
    - Smaller Laguna Lake
  - 5. Scenedesmus
    - Largest Laguna Lake
  - 6. Navicula
    - Laguna Canyon
    - Algae Pool
    - Salt Spring
    - Sulphur Spring
    - Smallest L. Lake
  - 7. Amphora
    - Algae Pool
  - 8. Cymbella
    - Sulphur Spring
    - Smallest Laguna Lake
    - Largest Laguna Lake
  - 9. Pinnularia
    - Smallest Laguna Lake
    - Salt Spring
  - 10. Gomphonema
    - Smallest Laguna Lake
  - 11. Closterium
    - Smallest Laguna Lake
  - 12. Pleurosigma
    - Smallest Laguna Lake
  - 13. Epithemia
    - Smallest Laguna Lake

III. Protozoa

- A. Amoeboid
  - 1. Amoeba
    - Algae Pool
  - 2. Nuclearia
    - Salt Spring
- B. Flagellate
  - 1. Euglena spirogyra
    - Smallest Laguna Lake
  - 2. Euglena sp.
    - Laguna Canyon
    - Laguna Slough
  - 3. Phacus longicaudis
    - Smallest Laguna Lake
    - Laguna Canyon
- C. Ciliate
  - 1. Gonium
    - Smallest Laguna Lake
  - 1. Flexiphyllum
    - Smallest Laguna Lake
  - 3. Condylostoma
    - Smallest Laguna Lake
    - Largest Laguna Lake

Laguna Canyon

4. Paramoecium
   Laguna Slough
   Algae Pool
   Sulphur Spring
   Salt Spring
5. Lacrymaria
   Laguna Canyon
6. Stentor (fixed)
   Laguna Canyon Stentor (moving) Smaller L. Lake
7. Vorticella
   Smallest Laguna Lake
   Laguna Slough
   Algae Pool
   Laguna Canyon
8. Volvox
   Largest Laguna Lake

IV. Flat Worms
1. Jensenia
   Laguna Canyon

V. Round Worms
   Smallest Laguna Lake
   Laguna Canyon
   Algae Pool

VI. Rotatoria
A. Rotifer neptunis
   Smallest Laguna Lake
B. Rotifer citrinus
   Sulphur Spring
   Salt Spring
   Laguna Canyon
C. Diplois
   Smallest Laguna Lake
D. Colurus grallator
   Smallest Laguna Lake
   Salt Spring
   Laguna Canyon
   Algae Pool
E. Notius quadricornus
   Smallest Laguna Lake
F. Philodina roseola
   Laguna Canyon

VII. Gastrotricha
A. Chaetonotus
   Laguna Canyon
   Smallest Laguna Lake

VIII. Copepoda
A. Cyclops
   Sulphur Spring

Preliminary List of Microscopic Life in Fresh Water Around Claremont

The numbers after the genera refer to the stations where the collections were made.

I. Algae
- A. Blue-green
  - 2. Oscillatoria 3, 6, 7, 9.
  - 3. Nostoc 1, 9.
  - 4. Merismopedia 2, 3, 4.
  - 5. Spirulina 2.
  - 6. Mastigonema 3.
- B. Green
  - 1. Vaucheria 11.
  - 2. Cladophora 4, 8, 11, 13, 14, 15.
  - 3. Clamydomonas 2, 3, 7, 8, 13, 14, 15.
  - 4. Gonium 13, 14, 15.
  - 5. Spirogyra 1, 3, 5, 7, 8, 9, 14.
  - 6. Ulothrix 13.
  - 7. Mougeotia 13.
  - 8. Mydrodictyon 2.
  - 9. Pediastrum 2, 12.
  - 10. Scenedesmus 2.
  - 11. Chlorosphaera 3.
  - 12. Chaetophora 8, 9, 14.
  - 13. Zygnema 7, 8.
  - 14. Chlorogonium 7.
  - 15. Myxonema 7.
- C. Diatoms
  - 1. Navicula 1, 2, 3, 4, 7, 8, 9, 11, 12, 13, 14, 15.
  - 2. Epithemia 8, 9, 12, 14, 15.
  - 3. Synedra 1, 2, 3, 4, 5, 7, 8, 9, 13, 14, 15.
  - 4. Cocconeis 1, 3, 5, 8, 9, 13, 14, 15.
  - 5. Siurella 7, 8, 12, 13, 14, 15.
  - 6. Gomphonema 1, 2, 3, 4, 5, 7, 8, 13, 15.
  - 7. Amphora 2, 7, 8, 13, 15.
  - 8. Nitzschia 1, 4, 7.
  - 9. Rhoicosphenia 3, 4, 7.
  - 10. Tabellaria 7.
  - 11. Cymbella 2, 13, 15.
  - 12. Selenastrum 2.
  - 13. Cyclotella 2, 4, 13.
  - 14. Pinnularia 2.
  - 15. Encyonema 3, 8, 13, 14.
  - 16. Denticula 3, 5, 8, 11, 14.
  - 17. Eunotia 4, 13, 14.
  - 18. Plagiogramma 4.
  - 20. Triceratium 4.
- D. Desmids
  - 1. Cosmarium 3.
  - 2. Closterium 2, 5, 8, 9, 13, 14, 15.

II. Protozoa
- A. Amoeboid
  - 1. Actinosphaerium 3.
  - 2. Amoeba limax 1, 13, 14.
  - 3. Amoeba 3.
  - 4. Acanthocystis 13.
  - 5. Noclearia 2, 3.
- B. Flagellate
  - 1. Euglena 5, 6, 7, 13, 14, 15.
  - 2. Peranema 6, 7.
  - 3. Notosolemus 6.
  - 4. Eutreptia 6.
  - 5. Atractonema 7.
  - 6. Phacus 7, 15.
  - 7. Astasia 3.
  - 8. Cephalothamnium 1, 13, 14, 15.
  - 9. Urceolus 14.
  - 10. Heteronema 14.
  - 11. Trentonia 15.
- C. Ciliate
  - 1. Vorticella 1, 2, 5, 6, 8, 13, 14.
  - 2. Stentor 13, 14, 15.
  - 3. Stentor polymorphus 14, 15.
  - 4. Linotus 14.
  - 5. Colpodium 12.
  - 6. Leucophrys 7, 14.
  - 7. Euplotes 1, 3, 6, 8, 13, 14.

8. Cinetochilum 3, 4, 14.
9. Cothurnia 14.
10. Paramoecium 1, 2, 3, 6, 8, 15.
11. Pleuronema 2, 7, 8.
12. Stylonychia (long) 2, 3, 7, 8, 12.
13. Stylonychia (oval 8, 15.
14. Oxytricha 5, 8, 10.
15. Chilodon 1, 3.
16. Chaenia 1, 2, 3, 6, 8, 11.
17. Atractonema 1.
18. Ophryglena 1.
19. Frontonia 1.
20. Glaucoma 2.
21. Condylostoma 3.
22. Coleps 3, 8, 15.
23. Colpoda 8, 12.
24. Metopus 8.
25. Halteria 7.
26. Spirostomium 6.
27. Blepharisma 15.
28. Opercularia 15.

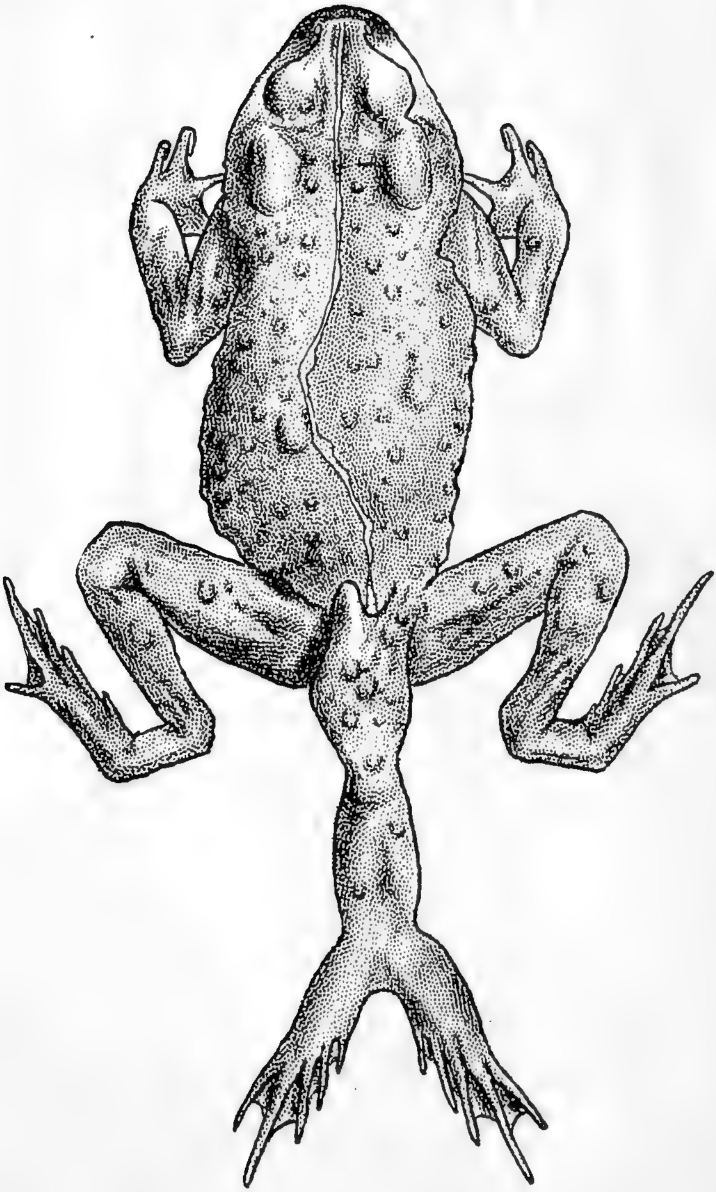
III. Rotifera
1. Pleurotrocha 8.
2. Philodina 6, 8.
3. Gastropus 1.
4. Diplax 3.
5. Diplois 1, 13, 14, 15.
6. Branchionus 5, 13, 14, 15.
7. Rattulus 14.
8. Floscularia 14.
9. Diaschiza 13, 15.
10. Melicerta 15.

IV. Gastrotricha
1. Chaetonotus

V. Crustacea
A. Ostracoda
1. Cypris 7, 9.
2. Herpetocypris 11.

B. Cladocera
1. Alonella 11.

(Contribution from the Zoological Laboratory of Pomona College.)



This peculiar toad was brought into the laboratory by Mr. M. Wyman. The drawing is by Mr. E. Crosswhite. The toad lived for some time and a few things were learned about its extra leg with the two feet.

1. It was capable of feeble movements of the leg and feet.
2. There was no true joint at the junction of the fifth leg with the body.
3. The extra leg was dragged along with no attempt made to use it in any way.
4. The extra leg could be used as a brace when the toad tried to climb from a jar.

(Contribution from the Zoological Laboratory of Pomona College.)

General Reactions of a Centipede

SUSIE CASE

This paper deals with the locomotion and general reactions resulting from experimentation upon the nervous system of centipedes. The nervous systems of these forms are very good for such experimentation, as the ganglia are distinct and widely separated.

There seem to be but three or four papers on the subject—two of these being on the physiology of the brain and *not* behavior, and one, "On the Movements of Millipedes and Centipedes" by E. Ray Lankester. I should like to mention several points which were observed along this last line. The locomotion of the centipede can be better emphasized by comparing it with that of the millipede. In the millipede one of the most apparent characteristics is the movement of the legs in waves, the pairs on opposite sides moving together, identically. The legs form groups of two pairs to a segment and these start the motion from the tail end forward. From five to eight distinct waves can be counted when all the legs are in motion. Millipedes move straight forward. On the other hand, the centipede as stated by Lankester, "contributes the serpentine stroke to the process of locomotion." It does not have the distinct waves mentioned in locomotion of the millipede. The legs on the opposite side do not move identically but are antagonistic in phase; and move in perfect harmony unless there be some injury to the nervous system, which controls locomotion. I agree with Lankester that it is most probable that the condition presented by the centipede in locomotion is a higher development than that shown by the millipede. The wave movement suggests a type found in lower invertebrates.

Th reverse locomotion of the centipede is very interesting. Most of them *persist* in going forward and yet in testing to find some definite result, I have discovered that occasionally they will, with persuasion, go backward. Most often, however, they turn the entire body instead of reversing the movements of the legs. On the other hand, all millipedes with persuasion will reverse for a short distance. When one goes backwards, it reverses the motion of the waves also, causing them to go from head to tail instead of from tail to head.

I have mentioned the two main observations of general behavior as to locomotion and shall now go on to the definite experiments which were made on the centipede to test specific reactions.

First as to the method: The specimen to be operated upon was pinned out on cork—the pins not being put through the centipede but across in a sufficient number of places to hold it firmly. The cut was made from the dorsal side into the nervous system. We tried not to make the external cut any larger than was absolutely necessary. When in doubt as to the position of the injury, we examined the animal after death.

The experiments and results are as follows:

Experiment I...Twelfth connective cut on right side. Results:

1. Some lack of movement in legs near cut and on same side, probably due to injury of muscles.

2. Tests to see whether stimuli carried from tail end to head end on injured side. Anal leg pinched. We have the suggestion in this that the impulse travels up and crosses over to the opposite side at the injured point, causing the head to turn to the right. On the uninjured side the impulse is able to travel up without crossing. The reaction was quicker than on the injured side.

3. Acetic acid on antennae of injured side. Reaction on opposite side at anal end first. Acetic acid on antennae of uninjured side. Reaction on same side at anal end.

4. When stmulated below cut, both sides respond equally well. All of these tests show that movement is deferred on the injured side.

Experiment II. Similar results obtained by cutting connective in fourteenth segment on right side.

Experiment III. Cut two connectives of twelfth segment. Results:

1. Specimen was turned on its back. It could turn over above injury without aid, was helpless back of injury.
2. Moved legs vigorously above injury; dragged others.
3. Antennae sensitive to touch, causing response back to injury.

Experiment IV. Results similar to experiment three obtained by cutting two connectives between last two ganglia.

Experiment V. Connectives cut between brain and sub-ganglion. Results:

1. Stimulated antennae. No response.
2. Stimulate anal leg. Impulse traveled along slowly, causing all legs to move. This seems to be a muscular reaction rather than one controlled by the nervous system.
3. One response in which I was very much interested was that the centipede, as a result of this particular experiment, reversed movement with apparent ease.

Experiment VI. Two alternating connectives cut. Results:

1. Specimen very active. Tests showed good crossing of sensation paths.

Experiment VII. Four cuts alternating excepting for second cut. Between cuts one and two connectives not severed on either side. Results:

1. Test to see whether stimuli carried to brain. Very slight stimulus at anal leg, caused only reaction in legs back of injury. Strong stimulus, caused stimulus to go to brain but it was very slow, due to the number of injuries. The stimulus had to cross at several points.
2. There is apparent separation of brain from anal end by injuries. The legs in front of injuries in constant motion, while those in back are quiet.
3. Stimulated head region. Result is a very active reaction, which takes place almost immediately, back to the injured part. There was much delay here. Gradually the response extended farther down.

Experiment VIII. Connective cut on left side in fifth segment from head. Connective cut on right side in fourth segment from tail. In this experiment I wanted to test for time of response when cuts are on opposite sides and quite a distance apart. Results:

1. Anal legs stimulated. On the right side it took longer for the response at the head end. On the left side it was carried immediately to brain. This was probably due to thé position of the segment where crossing over took place.

2. Legs stimulated at center of body. Anal end drew up on the side stimulated. This reaction took longer on the right side, because the stimulus had to cross at the injury.

3. From the injury of the nervous system of the muscles, the specimen moved with a swinging motion. It could reverse its movements.

Experiment IX. About one-third of the brain was removed, the right connective was severed between the brain and the next ganglia, all connections with the eye were severed on the same side. Results:

1. No co-ordination of leg movement. Legs interfered with one another.

2. At first, no sense of correct position. As willing to stay on back as normal position.

3. Most noticeable result was that it reversed movement with apparently as much ease as it went forward. It traveled the length of the dish. This centipede lived twenty-four hours.

Experiment X. Removed sub and supra ganglia. Results:

1. Had better co-ordination of leg movement than one with one-third of brain removed *(Experiment IX),* however, it needed stimulation for movement. A slight jar of the dish was stimulus enough for the reaction. After this experiment the centipede lived sixty hours, thus showing the injury to be less of a shock than in experiment nine.

Experiment XI. The centipede was cut into nearly equal parts. This last experiment is of a different type but results are along the same line as others. Results:

1. In tail half there seems to be co-ordinated reaction of legs, suggesting that the symmetry has not been interfered with. It turns toward side stimulated. Tail end remained alive a little over two hours.

2. The head end was again cut into two parts. The central section was active and remained alive for two hours. The head end was very active. It had initiative to move without being stimulated, which power the other two parts did not have. The head end remained alive three hours.

GENERAL CONCLUSIONS

1. The head ganglia seem to be necessary to initiate movements.

2. The body ganglia are rather independent centers for local control, and complete co-ordination is possible without the head.

3. The stimuli travel up and down the nervous system, both on the side stimulated and on the opposite side.

4. In case a connective is served on one side, the stimulus is capable of crossing over to the other side but the reaction is somewhat delayed.

5. When alternate connectives are severed for some distance, the stmulus, although delayed, passes from one end to the other. The delay is increased according to the number of connectives severed.

6. Centipedes as compared with millipedes do not as a rule reverse the movements of the legs, but unilateral injuries to the brain seem to permit the reverse movements upon stimulation.

(Contribution from the Zoological Laboratory of Pomona College.)

Notes on the Central Nervous System of a Free-Living Marine Nematode

WILLIAM A. HILTON

The species studied was the one which is most abundant at Laguna Beach among Algæ and in sand at low tide. It corresponds closely to *Enoplus brevis* Duj.

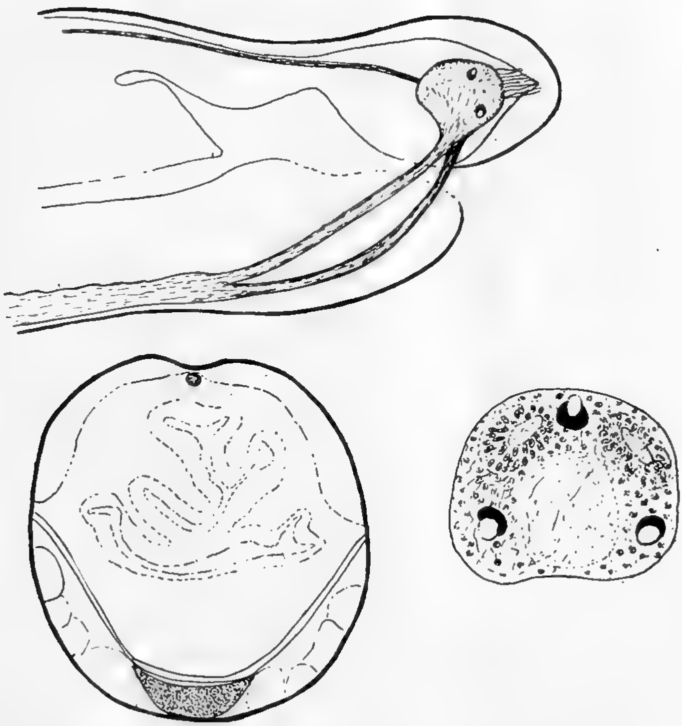
The nervous system has several features not described in related forms. There is a concentration of the central nervous system. There is a single large ganglion or brain in the snout above the mouth, from this two connectives pass ventrally to join the broad ventral nerve band in the mid-ventral line, while the only other longitudinal nerve noted was the very small mid-dorsal. Lateral nerves were not found.

The head or snout ganglion is provided with three eye spots, and unpaired dorso-median and a pair of latero-ventral ones. The sensitive region is so placed as to receive stimuli from above by the median eye and from below by the lateral eyes. The eyes are little more than concave pigment spots imbedded in the mass of the ganglion. A number of fibers pass from the ganglion forward to supply the thick sensory epithelium of the tip of the snout.

The ganglion is rather complex in structure. It has a central and somewhat ventral mass of fibers surrounded on all sides by nerve cells and fibers mingled. There are two centers composed each of cell areas surrounding a fibrous mass; these seem to be associated with fibers connected with the sensory epithelium of the snout and they resemble slightly the olfactory areas of certain invertebrate brains.

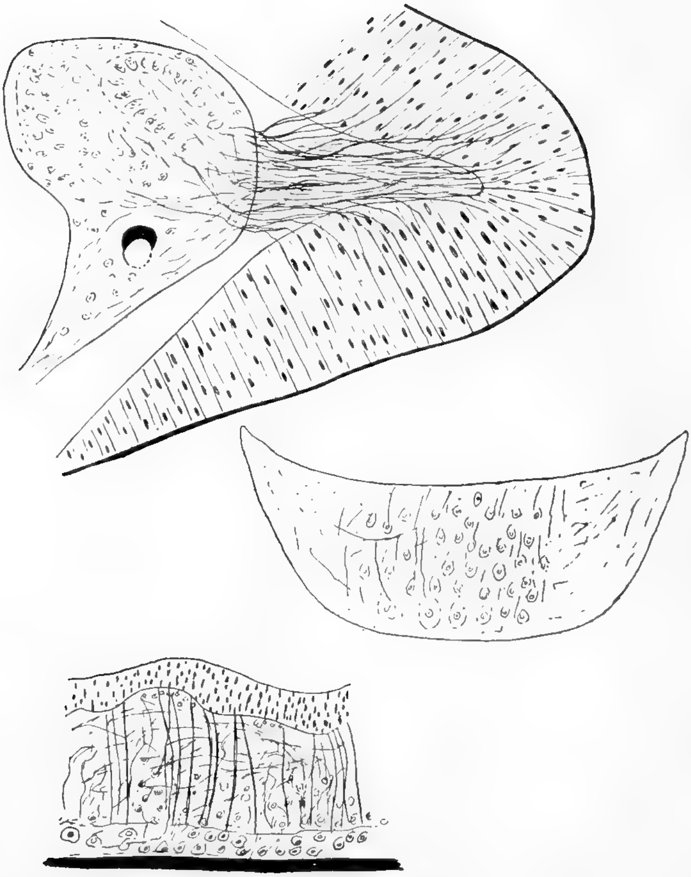
The dorsal nerve trunk is not cellular. The ventral nerve trunk is thick and broad. Ventrally it is nearly fused with the underlying cells of the body-wall, while dorsally it is bounded by a closely applied muscular layer. The nervous tissue itself is traversed by heavy lines which in part may be merely supportive in function, the lighter strands, both transverse and longitudinal, are branches from the rather abundant cells which are for the most part located ventrally.

(Contribution from the Zoological Laboratory of Pomona College.)



(FIG. 1.) EXPLANATION OF FIGURES

The figure above is a reconstruction of the head end of *Enoplus,* showing the position of the nervous system. The lower figure at the left is of a section through the whole body of the worm, showing the dorsal and ventral nerve bands. Both these figures enlarged 75 times. The drawing at the right is from a section through the head ganglion, enlarged 170 times. The dorsal side is up in all the figures.



(FIG. 2.) EXPLANATION OF FIGURES

The figure above is through the snout and ganglion of Enoplus. The central figure is a drawing of a cross-section of the ventral nerve band. The lowest figure is from a longitudinal section of the ventral nerve band with the muscular layer above and the body-wall below.

The dorsal side is up in all the figures and all are enlarged 275 times.

New Species of Crane-Flies from the United States and Canada

(Tipulidæ, Diptera).

By Charles P. Alexander, State Natural History Survey, Urbana, Illinois.

Most of the new species described in the present paper were found among material sent to the writer for identification. I am greatly indebted to Mr. W. L. McAtee and to Mr. F. R. Cole for the privilege of studying and describing many of the species included in this paper. Two interesting forms were collected in southern Illinois during the season of 1919 by Mr. Malloch and the writer.

Family Tipulidæ.

Subfamily Limnobiinæ.

Genus *Dicranomyia* Stephens.

Dicranomyia terræ-novæ sp. n.

General coloration gray, the præscutum with three dark brown stripes; antennæ dark brown throughout, the flagellar segments short-oval; wings with a heavy dark brown pattern, including five large costal blotches; *Sc* short, basal deflection of *Cu1* far before the fork of *M.*

Male.—Length about 5.5 mm.; wing, 7.6 mm.

Female.—Length about 7.5 mm.; wing, 7.7 mm.

Rostrum dark brown; palpi brownish black. Antennæ dark brown, the flagellar segments short-oval, clothed with an abundant pale pubescence. Head bright silvery on the front, duller on the posterior parts of the head; a conspicuous brown line on the vertex.

Pronotum dark brown. Mesothorax very deep, the mesonotum gibbous. Mesonotal præscutum light gray with three conspicuous dark brown stripes, the broad median stripe indistinctly split by a capillary line; scutum gray with the lobes dark brown; scutellum and postnotum gray, the latter with a delicate brown median line. Pleura light gray with an indistinct brownish longitudinal stripe extending backward from the fore coxæ; a similar line on the mesosternum. Halteres yellow, the knobs dark brown. Legs with the coxæ small, gray; trochanters dull yellow; femora brownish yellow, the tips indistinctly darker; tibiæ and tarsi brown. Wings whitish subhyaline with a heavy brown and grayish pattern, as follows: five dark brown blotches along the costal margin, the first near the wing-base, the third at the tip of *Sc* and the origin of *Rs,* the fourth at the tip of *R1,* the last at the tip of *R2+3,* suffusing the wing-apex; the first three of these markings reach the costa and pass into cell *R;* the fourth (stigmal) is rectangular, connected with a blotch at the fork of *Rs;* narrow brown seams along the cord and the outer end of cell *1st M2;* large brownish gray clouds along the margin at the ends of the veins and at the anal angle of the wings. Venation: *Sc* short, ending just beyond the origin of *Rs, Sc2* indistinct, apparently somewhat removed from the tip of *Sc1,* this distance about equal to the basal deflec-

tion of *M1+2;* basal deflection of *Cu1* far before the fork of *M,* this distance about equal to the basal deflection of *M1+2.*

Abdomen dark brown, the posterior margins of the segments broadly silvery.

Habitat.—Newfoundland.

Holotype, ♀, Spruce Brook, August 8-12, 1912 (G. H. Englehardt), (No. F3192).

Allotopotype, ♂.

Paratopotype, ♀.

Type in the collection of the American Museum of Natural History.

Dicranomyia terræ-novæ differs conspicuously from all the described American species of the genus. Its vicarious Palæarctic representative is *D. decora* (Staeger) of Northern Europe. Superficially it bears a marked resemblance to *Geranomyia rostrata* (Say), from which the structure of the mouth-parts and the slightly different venation will separate it.

Genus *Elliptera* Schiner.

Elliptera illini, sp. n.

General coloration brown, the pleura yellowish; cell *1st M2* open.

Female.—Length about 5 mm.; wing, 6 mm.

Rostrum pale brown, the palpi dark brown. Antennæ with the scapal segments pale yellowish, the flagellum black; flagellar segments oval with a sparse white pubescence and verticils that are a little shorter than the segments. Head dark brownish black.

Thorax dull yellow, the thoracic dorsum with the stripes brown and entirely confluent, shiny, only the lateral margins of the præscutum yellowish. Halteres dark brown, the base of the stem more yellowish. Legs with the coxæ and trochanters dull yellow; remainder of the legs brown, the base of the femora paler. Wings gray, the stigma indistinct; veins dark brown. Venation: *Sc* rather short, ending about opposite two-thirds the length of the long sector; *Sc2* proximad of the origin of the sector, the distance about equal to the basal deflection of *Cu1;* basal deflection of *R4+5* almost square and in one wing of the type strongly spurred at the angle; cell *1st M2* open by the atrophy of the outer deflection of *M3, M1+2* before *m* about one-half that beyond this cross-vein; basal deflection of *Cu1* just before the fork of *M.*

Abdominal tergites dark brown, the sternites yellowish.

Habitat.—Illinois.

Holotype, ♀, Makanda, Jackson County, June 4, 1919 (Alexander).

Type in the collection of the Illinois State Natural History Survey.

The unique type of *Elliptera illini* was found in the "Ozark" region of Illinois while Mr. Malloch and the writer were engaged in an entomological survey of this section. The genus *Elliptera* was hitherto represented by two species from Europe and two species from North America west of the Rockies. The occurrence of the genus east of the Mississippi River was quite unexpected and breaks the hitherto discontinuous distribution of this curious genus of crane-flies. The present species differs from its American relatives in the open cell *1st M2,* a character possessed by both of the European forms.

Genus *Orimarga* Osten Sacken.

Orimarga wetmorei sp. n.

General coloration black; thoracic pleura and lateral margin of the præscutum striped with silvery; legs pale yellowish brown, the tips of the femora a little paler; wings subhyaline, the veins pale brown; tip of *R1* atrophied or indistinct; deflection of *R4+5* very long.

Sex, female?—wing, about 4 mm.

The type is badly discolored. The general coloration is a dark brownish black; basal segments of the antennæ paler, the flagellar segments nearly globular.

The mesonotum has the extreme lateral margins of the præscutum narrowly silvery, the pleura with a broad silvery longitudinal stripe, this type of coloration being similar to that in *O. argenteopleura.* Legs light yellowish brown, the tips of the femora indistinctly paler; tarsi darker. Wings subhyaline, the veins pale brown, more yellowish along the costal margin. Venation: *Sc* moderately long, ending at about one-third the length of the long sector; *Rs* strongly arcuated at its origin; tip of *R1* atrophied or retreated back almost to the tip of *Sc1; r* very long and strongly arcuated; basal deflection of *R4+5* very long, strongly arcuated at its origin, more than half the length of *Rs;* cell *M3* deep; *r-m* far beyond *r.*

Abdomen dark brownish black, the apex broken.

Habitat.—Florida.

Holotype, Sex?, Paradise Key, February 22, 1919 (Alex Wetmore).

Type in the collection of the United States Biological Survey.

O. wetmorei is the sixth American species to be described, the second from the United States. The fly differs conspicuously from *O. arizonensis* Coq. (Arizona) in the coloration of the legs and body and in the venation. It is much more like *O. argenteopleura* Alex. (Guatemala) which has the thorax similarly colored; this latter species is considerably larger, with dark brown legs and a very distinct venation (tip of *R1* short, persistent; basal deflection of *R4+5* short).

The species is dedicated to the collector, Alex Wetmore.

Genus *Erioptera* Meigen.

Erioptera (Erioptera) oregonensis, sp. n.

Size large (wing of the male over 7 mm.); general coloration brown, including the halteres; wings with a strong brownish suffusion.

Male.—Length, 6 mm.; wing, 7.3 mm.

Rostrum and palpi dark brown. Antennæ dark brown, moderately elongate, clothed with a dense white pubescence, the verticils of the more terminal segments very long. Head dark brown, more grayish brown around the eyes.

Mesonotum dark brown with indistinct stripes on the præscutum, the lateral margins of which are indistinctly paler; humeral angles not noticeably brightened; tuberculate pits small, widely separated; scutum, scutellum and postnotum sparsely yellowish gray pruinose. Pleura dark brownish black, gray pruinose. Halteres long and slender, dark brown, only the base of the stem a little brightened. Legs with the coxæ dark, grayish pruinose; remainder of the legs dark brownish black, only the trochanters and the bases of the femora a little brighter. Wings with a strong grayish

brown suffusion; stigma dark brown; an indistinct brown cloud along *r-m* and the deflection of *R4+5;* veins dark brown. Venation as in the subgenus, the *2nd Anal* vein strongly sinuate.

Abdomen dark brownish black with a paler brown pollen. Hypopygium a little brighter; pleurites short and stout, sparsely setigerous; two pleural appendages, the outer appendage larger, the outer end flattened and enlarged, along the margin with four parallel rows of fine comb-like points; inner appendage paddle-like, the blade suddenly enlarged, provided with a few setigerous punctures, at the extreme tip with an additional, powerful, curved bristle. Penis-guard straight, tapering gradually to the blunt tip; gonapophyses with the apices produced laterad into conspicuous triangular blades with the points directed laterad.

Habitat.—Oregon.

Holotype, ♂, Tillamook, March 26, 1919, (A. C. Burrill).

Genus *Ormosia* Rondani.

Ormosia subcornuta, sp. n.

Belongs to the *meigenii* group; closely allied to *O. cornuta* (Doane) but the veins stouter, the stigma distinct, and the details of the male hypopygium very different.

Male.—Length, about 3.5—3.8 mm.; wing, 4.3—4.7 mm.

Female.—Length, about 3.8—4 mm.; wing, 5 mm.

Rostrum and palpi dark brown. Antennæ moderately elongate, dark brownish black, the scapal segments slightly paler brown. Head gray, provided with conspicuous yellow setæ.

Thoracic dorsum brownish gray without distinct stripes, the lateral margins more yellowish; tuberculate pits shiny black, located close together, the distance between them less than the diameter of one. Pleura brown with a strong gray pruinosity; a large tuft of yellow setæ between the base of the wings and the base of the halteres and a second group immediately ventrad of the halteres. Halteres yellow. Legs with the coxæ dark, gray pruinose; trochanters dull brown; remainder of the legs dark brown, the bases of the femora a little brighter. Wings subhyaline; stigma large, dark brown; veins stout, dark brown. Venation: cell *1st M2* open by the atrophy of the outer deflection of *M3; 2nd Anal* vein slightly sinuous on its distal half, converging toward the *1st Anal* vein.

Abdomen dark brown. Male hypopygium with the pleurites stout, provided with numerous conspicuous setigerous tubercles that bear long yellowish setæ which become more elongate and stouter toward the tips of the pleurites; outer pleural appendage subglobular, armed with from 4 to 8 powerful, acute spines, the terminal spine large, along the outer face with microscopic, appressed denticles, the basal spine on the inner side of the appendage largest, strongly incurved; inner pleural appendage long, slender, with a strong spine before the tip to produce a bifid appearance. The most lateral pair of gonapophyses are sinuous, with a group of two or three teeth or spines on the inner face some distance before the tip, the slender apex beyond these slightly curved; the proximal pair of gonapophyses are almost straight, very slender, the tip with numerous indistinct denticles, at the extreme base with a few conspicuous spines; an additional pair of gonapophyses whose apices are conspicuously flattened, with the point of the blade directed laterad and slightly cephalad. Ninth sternite

with a broad spatulate blade, as in the *meigenii* group of this genus, the apex deeply notched medially.

Habitat.—Oregon.

Holotype, ♂, Forest Grove, March 26, 1919, (F. R. Cole).

Allotopotype, ♀.

Paratopotypes, 2 ♂s; paratypes, 1♂, 1♀, Hillsboro, April 1, 1919, (F. R. Cole).

This little species is evidently the Western representative of the common *O. meigenii* (O. S.) of the Eastern States, its general appearance being very like that species. In the structure of the male hypopygium, however, it runs closes to *O. cornuta* (Doane), which may be told by the different color of the wings and the structure of the hypopygium.

Genus *Gonomyia* Meigen.

Gonomyia (Gonomyia) coloradica, sp. n.

Belong to the *blanda* group, closest to *mathesoni* Alex.; general coloration yellowish, the præscutum with three broad, confluent stripes of reddish brown; wings with the petiole of cell *M2* long; male hypopygium with the structural details very different from those in *G. mathesoni.*

Male.—Length, about 4.5 mm.; wing about 6 mm.

Rostrum, palpi and antennæ dark brown. Head dark.

Pronotal scutum and the collare dark brown; pronotal scutellum pale. Mesonotal præscutum with three broad, reddish-brown confluent stripes, the humeral regions cephalad of the lateral stripes pale; scutellum pale. Pleura pale, indistinctly striped with brown. Halteres pale, the knobs dark brown. Legs with the coxæ and trochanters pale; femora light brown; remainder of the legs broken. Wings subhyaline, unspotted; stigma lacking; veins brown. Venation: almost as in *G. mathesoni* with the following details different: *R2* very oblique and apparently contiguous with the tip of *R1; R2+3* not angulated before the middle of its length and without a faint spur of *r* at this point; petiole of cell *M2* much longer, one-half longer than the fused portion of *Cu1* and *M.*

Abdomen light brown. Male hypopygium generally similar to that of *G. mathesoni,* differing as follows: The bifid pleural appendage is very similar in the two species, in the present species with the needle-like tip of the longest arm abruptly pale. The long, sinuous appendage in *mathesoni* is here represented by two, the longer of which is pale throughout, flattened, the long tip acicular and almost straight; the shorter appendage is flattened, before the tip a little expanded, with a long, slender, curved black-tipped apex. Near the base of these pleural appendages is a flattened subtriangular lobe which is covered with an abundance of short setæ; in *G. mathesoni,* this appendage is very small, cylindrical, with but few setæ and with a distinct finger-like spinous lobe on one side. Penis-guard distinctly trifid at its apex, the lateral black spines directed almost caudad, setigerous at their bases; a shorter median pale lobe.

Habitat.—Colorado.

Holotype, ♂, Longview, June 24, 1916 (E. C. Jackson).

Type in the collection of the United States Biological Survey.

Genus *Phyllolabis* Osten Sacken.

Phyllolabis latifolia, sp. n.

General coloration light gray; wings pale gray, the stigma pale grayish brown; *R2+3* shorter than *R3* alone; cell *1st M2* short; male hypopygium yellow with the foliaceous appendage of the eighth sternite very broad and but indistinctly bifid at its tip.

Male.—Length about 6.5 mm.; wing, 7.5 mm.

Rostrum dark brown, heavily gray pruinose above; mouth-parts reddish brown; palpi dark brown. Antennæ moderately elongate, dark brown throughout, the flagellar segments long-oval, provided with venticils that are but little shorter than the segments. Head light gray with an indistinct black median line.

Pronotum rather large, heavily light gray pruinose. Mesonotal præscutum brownish gray pruinose without distinct stripes; pseudosutural foveæ black, short-triangular; tuberculate pits not evident; remainder of the mesonotum gray pruinose, the scutellum more brownish. Pleura clear light gray. Halteres pale. Legs with the coxæ and trochanters pale brownish yellow; remainder of the legs dark brown, the bases of the femora paler. Wings pale gray; stigma rather indistinct, pale grayish brown; veins dark brown; *Sc* and the abortive vein behind *Cu* more yellowish. Venation similar to *P. claviger* but *R2+3* shorter, less than *R3* alone; veins *R2* and *R3* more divergent, *R2* at the wing-margin being distinctly closer to *R1* than to *R3;* cell *1st M2* shorter, especially the outer deflection of *M3.*

Abdomen brown, sparsely gray pruinose. Hypopygium light yellow, including the pleurites and pleural appendages. Genitalia similar to *P. claviger,* differing as follows: outer angle of the pleurite much longer, projecting conspicuously beyond the pleural appendages; dorsal pleural appendage not slender and strongly bent at mid-length but very broad and flattened, roughly subtriangular with the base narrowest. Foliaceous appendage of the eighth sternite very broad and flattened, widest at the base, thence with the sides almost parallel slightly expanded at the distal end, the caudal margin of this leaf-like lobe slightly concave, feebly or indistinctly notched medially.

Habitat.—Oregon.

Holotype, ♂, Forest Grove, March 28, 1919 (F. R. Cole).

Genus *Tricyphona* Zetterstedt.

Tricyphona sparsipuncta, sp. n.

Close to *T. septentrionalis* Bergr.; median præscutal stripe split by a pale line; wings subhyaline, the costal region more yellowish; *r-m* connecting *R4+5* and *M1+2.*

Female.—Length, 7.5—8.8 mm.; wing 9.2—11 mm.

Rostrum very short, transverse, dark brown, sparsely gray pruinose, the anterior margin with a row of a few long yellowish bristles; mouth-parts and palpi dark brown. Antennæ dark brownish black, the basal four or five segments enlarged and very crowded as in this group of species. Head dark brown above, the front and a narrow margin around the eyes and across the anterior part of the vertex light gray.

Mesonotum very high and gibbous. Mesonotal præscutum light grayish yellow, with three dark brownish stripes, the median stripe split by an indistinct pale capil-

lary line that is more distinct in front; the sides of the median stripe are nearly parallel; lateral stripes narrow, their anterior ends subacute; scutum with the lobes marked with brown; scutellum light gray. Pleura dark brown, gray pruinose. Halteres pale yellowish brown, the knobs dark brown. Legs with the coxæ brown on the outer face; trochanters dull yellow; femora and tibiæ dull yellow, tipped with dark brown; tarsi dark brown, the base of the metatarsi paler. Wings subhyaline, the costal and subcostal cells more yellowish; stigma oval, dark brown, paler distally; sparse brown clouds along the cord, at the fork of *R4+5,* along the outer end of cell *1st M2* and, less distinctly, at the base of the sector; veins dark brown, *Sc* more yellowish. Venation: The distance between *Sc2* and the origin of the sector shorter than the straight portion of the sector alone; *Rs* angulated and spurred at its origin; upward deflection of *R2* slightly oblique, inserted in *R1* rather far before its tip, so that *R1+R2* is greater than the deflection of *R2* alone; petiole of cell *R4* short, about one-fourth longer than *r-m; r-m* inserted between *R4+5* and *M1+2;* petiole of cell *M1* longer than this cell.

Abdomen dark brown; valves of the ovipositor reddish brown, strongly compressed, slightly upcurved at the tip.

Habitat.—Oregon.

Holotype, ♀, Hillsboro, April 1, 1919 (F. R. Cole).

Paratype, ♀, Corvallis, May 14, 1917 (Moulton).

The type is much larger than the paratype but undoubtedly refers to the same species. The fly is closest to *T. septentrionalis* Bergr. (Alaska) in its spotted wings but may be distinguished by the colorational and venational details as described above.

Subfamily Tipulinæ.

Genus *Tipula* Linnæus.

Tipula mallochi, sp. n.

Belongs to the *submaculata* group; close to *T. submaculata* Lw.; male hypopygium with the horns of the tergite short, outer pleural appendage not bifid, gonapophyses short, eighth sternite with two powerful decussate bristles.

Male.—Length, 15 mm.; wing, 17—17.4 mm.

Female.—Length, 20 mm.; wing, 18.5—19 mm.

Frontal prolongation of the head brown, more yellowish above; palpi pale brown. Antennæ bicolorous, the flagellum with the basal enlargement of each segment black, the remainder light yellow, on the apical segments a little more infuscated. Head yellowish brown with a sparse grayish bloom; a capillary dark brown median line.

Mesonotal præscutum dull brownish yellow with four rather narrow reddish brown stripes, the remainder of the dorsum yellowish. Pleura pale yellow, whitish pollinose. Halteres pale, the knobs dark brown. Legs with the coxæ pale whitish yellow; trochanters yellow; remainder of the legs darker. Wings pale gray, the base of the wings and the costal region more yellowish; stigma brown; a brown cloud at the origin of the sector; tip of the wing indistinctly darkened; obliterative area before the cord in the base of cell *R2.*

Abdominal tergites dull brownish yellow, on the sixth to ninth tergites dark brown; the caudal margins narrowly, the lateral margins more broadly, silvery;

segments two to five with a narrow longitudinal brown sublateral streak; sternites brown, the caudal margins of the segments pale. Hypopygium generally similar to *T. submaculata,* differing as follows: Ninth tergite with the lateral horns very short and broad, the tips acute, not long and tapering as in *submaculata;* outer pleural appendage short and broadly flattened, the apex subtruncated, with a few coarse setigerous teeth, in *submaculata* this appendage is more slender, tapering to the acute point, at about midlength on the outer margin with a prominent spine to produce a bifid appearance; gonapophyses broad and flattened at the base, the slender tips short, not long and sinuous as in *submaculata;* eighth sternite with a pair of strong reddish fused bristles that are decussate, in addition to the smaller setæ. In the female, the sixth and seventh tergites are dark brown, the ovipositor acute, the tergal valves being especially long and slender.

Habitat.—Illinois.

Holotype, ♂, Alto Pass, Union County, June 5, 1919 (Alexander).

Allotopotype, ♀.

Paratopotypes, 4 ♂ ♀; paratypes, 20 ♂ ♀, Makanda, Jackson County, June 4, 5, 1919 (Alexander and Malloch); 5 ♂ ♀, Dubois, Washington County, June 3, 1919 (Malloch).

Type in the collection of the Illinois State Natural History Survey.

Tipula mallochi is common in the "Ozark" region of southern Illinois during early June, when it flies with other species of the genus as *T. submaculata* Lw., *T. tuscarora* Alex., *T. translucida* Doane, *T. morrisoni* Alex., *T. mingwe* Alex., *T. umbrosa* Lw., *T. flavoumbrosa* Alex., *T. fuliginosa* Say, and, in proximity of low wet cliffs, with *T. ignobilis* Lw.

Notes on Pacific Coast Pycnogonids

W. A. HILTON

The specimens reported on at this time were obtained at Laguna Beach in the summer of 1920. Their collection was more or less incidental to other littoral explorations. There is also included a list of forms obtained at other times and at other places, chiefly during the same summer at Pacific Grove.

Pallene californiensis, Hall.

Two of these were collected at Laguna Beach.

Lecythorhynchus marginatus, Cole.

Twelve specimens collected at Laguna Beach from among mussels, under rocks, among algae, etc. One specimen was dredged of San Diego in 1916. Thirty-four were collected on the land side of Catalina Island at the Isthmus in quite a different type of locality from that which is usual. At this place there were few red Algae but masses of a rather fine brown rock-weed. On these plants, hydroids and bryozoans were quite abundant. Many more might have been collected if there had been time.

Among Algae in front of the Hopkins Laboratory at Pacific Grove 18 specimens of this species were found. One was collected at the "Big Tide Pool."

Ammothella tuberculata, Cole.

Twenty specimens found in front of the Hopkins Laboratory at Pacific Grove. One found at low tide in the "Big Tide Pool." None found at Laguna this season.

A. bi-unguiculata, Dohrn, *var. californica,* Hall.

Twelve of these obtained at Laguna Beach under stones. Three specimens at the Isthmus, Catalina Island.

A. spinosissima, Hall.

Seven specimens collected at Laguna Beach. Two obtained at Pacific Grove in front of the laboratory.

Tanystylum intermedium, Cole.

Twenty-five specimens from Laguna Beach.

Clotenia occidentalis, Cole.

Ten specimens from Laguna Beach. Sixtey-three specimens from in front of the Hopkins marine station, some were found on plume hydroids and among Algae.

Halosoma viridintestinalis, Cole.

We usually find a number of this species at Laguna Beach but none were found this season. At Pacific Grove 68 were collected from masses of fine bryozoans from floating timbers.

Amoplodactylus erectus, Cole.

Specimens of this species may be obtained at Balboa among tubularian hydroids, a hundred or more were collected from this locality this year and one from Anaheim Landing with palm hydroids.

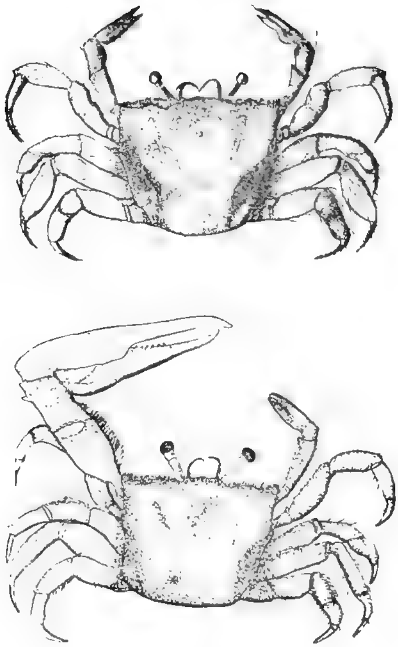
A. californicus, Hall.

Three specimens from Laguna Beach, 6 specimens from the Isthmus, Catalina Island, 1 specimen in front of the laboratory, Pacific Grove.

Pycnogonum stearnsi, Ives.

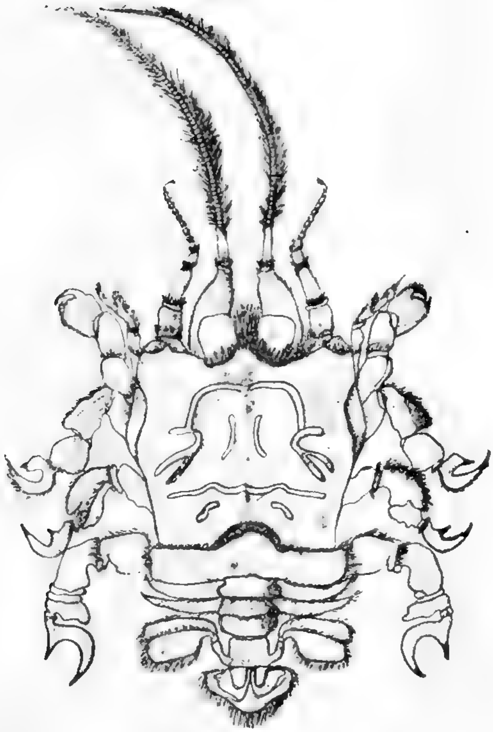
Seven specimens from Laguna Beach, 1 specimen from Pacific Grove.

(Contribution from the Zoological Laboratory of Pomona College)

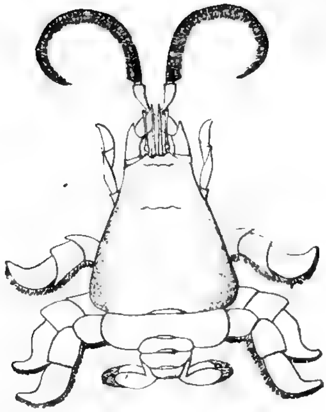


Uca. musica. Rathb.

Drawn by J. Caldwell from specimens obtained by Caldwell and Miss W. Durant at Balboa mud flats during the summer of 1920. This is the first record of a fiddler crab in our region. The male is shown with the large claw. Sometimes the large claw was on the right, sometimes on the left. Specimens brought to the laboratory in moist sand made their burrows and lived all summer. In spite of the larger claws of the males they gave way to the females when in each other's way.



Lepidopia myops, Stimp.
From Laguna Beach. Drawn by Joseph Caldwell.



Eremita analoga, Stimp.
Common sand crab of Laguna Beach. Drawn by Howard Lorbeer.

The Nervous System and Sense Organs

BEGINNING WITH THIS ISSUE A SERIES OF ARTICLES
WILL RUN FROM NUMBER TO NUMBER
WITH CONTINUOUS PAGING

By WILLIAM A. HILTON

I. Plants

One of the common properties of living things is irritability. All living substance reacts, responds to stimuli, whether they come from the outside or from within. Transmission of stimuli is also a common property of living matter.

Plants are sensitive to many sorts of stimuli without much indication of organs of special sense. Only in certain cases are there tissues for the transmission of the effects of stimulation and central organs for coördination and control seem to be entirely lacking.

In unspecialized organisms, both plants and animals, the surfaces are sensitive to many sorts of stimuli without special organs for their perception. The whole surface or the whole body may in a general way be sensitive. If there are special parts associated with special stimuli, there are no histological features to indicate them. This diffuse perceptive capacity is more characteristic of plants than animals, yet some animals are of this type, and many plants have structures which are truly organs of sense, and in some cases special tissues for the transmission of the effects of stimulation.

In certain parts of most plants there are areas of surface where the perception of stimuli takes precedence over the protective or other functions; such surfaces may be called sensory. Certain cells or cell groups in plants which have perception as their chief or only function may be called sense-organs, even though they may not be responsible for sensation in the psychological sense. So far as we know, plants have developed sense organs only in relation to a few forms of external stimulation, such as those of contact, shock or jar, gravity or static and photic or light stimuli. So far as we can tell, the real act of perception, so-called, always takes place within the living substance, mainly or entirely in the solid portions, or in the ectoplast.

Tactile pits occur in the outer walls of some surface cells. The cell walls are thin at these points, which are just over the sensitive protoplasm within the cells. These pits are usually confined to the sides of tendrils which may come into contact with surfaces. Darwin first determined that tendrils can be stimulated only by contact with, or friction against, solid objects, not by the impact of water.

Tactile papillae, knobs and hairs occur on various parts of plants, such as staminal filaments. Parts of flowers which exhibit movements are often stimulated by means of hairs or knobs. Movements of parts of insectivorous plants are initiated by means of special sensory structures, such as hair, knobs, or spines.

Plants respond to light in general without special organs of sense, but it is probable that the epidermal cells of many leaves are

arranged in such a way as to favor the reception of light waves. This is, of course, not alone for sensation, yet sensation may be an important function. Some epidermal cells bulge considerably, especially in the velvet-like leaves of tropical forests. Such elevations make it possible for the cells to perceive photic stimuli, even when their surfaces are wet. Sometimes a whole cell bulges in a lens-like manner; sometimes the wall is thickened like a little lens, and by these methods the rays of light are brought to a focus upon the inner sensitive protoplasm. In many plants the whole upper epidermis is developed as a light-perceiving or photic epithelium. Also at times the margin or some definite locality has cells especially adapted to focus and receive rays of light. Such cells alone or in groups are conical with rounded tips, the apex of each has its wall thickened or almost biconvex. Such so-called ocelli have been proved to condense the light more effectually than the ordinary surface cell.

Stigmata or eye spots are found in certain plant spores and among the flagellates, such as *Volvux. Euglena.* etc. In *Euglena* the light-perceiving ability is confined to sensitive protoplasm near the pigment spot. The eye spot or pigment therefore acts as a light-screen.

Geotropic movements of plants are remarkable. The plants of high organization especially seem sensitive to the stimuli of gravity. Certain cells of roots, stems and leaves are provided with movable starch grains. It has been suggested that the movements of these starch grains bring about changes for growth and movements appropriate to the needs of the plants.

Transmissions of stimuli take place within cells from the points stimulated to more distant portions, but they cannot well be determined. When the sensory and the reaction organs are more widely separated the conduction is more obvious. In plants there are but few examples of transmission at a distance, for in many cases of marked movements in plants the sensory areas immediately adjoin the motor tissue. In other cases the transmission is at a greater distance. The velocity of transmission in plants is much lower than in animals. Heliotropic and geotropic stimuli are said to require five minutes to travel two millimeters, traumic stimuli: 1-2 cm. per minute to 1-2 cm. a second. In case of the sensitive plant the transmission is 30-100 mm. per second.

Besides the transmission of impulses through the protoplasm of the cell there is the necessity for transmission from cell to cell. No special pathways have been clearly determined for the first in plants, but protoplasmic threads traverse the whole thickness of the cell walls. It is questionable whether there are special structures within plant cells for the conduction of stimuli. Strands between cells have been interpreted by some as the pathways of the effects of stimulation. There is no central organ of coördination known

and no distinction is needed between afferent and efferent pathways.

The only instance known of special tissues for the conduction of impulses is in the sensitive plant group and here it is quite definitely proved that living tissues are not necessary for the conduction of impulses and are in no sense comparable to the conductive tissues of complex animals.

II. Protozoa

In *Amoeba,* there seems to be no portion of the surface more sensitive than others. The exoplasm is a general sensory organ.

Experiments by Hyman '17, with toxic substance show that a local region of increased susceptibility exists along the axes of each pseudopodium from its distal to its proximal end, the distal end being more susceptible. The youngest and most vigorous forms are most susceptible.

According to several investigators, the exoplasm of *Amoeba* is like a tough skin and this in part at least acts as a sensory area. The more fluid endoplasm may become quite rigid under stimulation.

The changes in Amoeba which are the causes of amoeboid movement and behavior originate within the Amoeba and external stimuli do not act directly to produce those physical alterations which result in movement, but they act through the protoplasm of the Amoeba. The reactions of Amoeba are similar to the reflexes of more complex forms involving reception of stimuli, and the conduction of internal changes leading to response, but sensation, conduction and movement are not differentiated.

If one side of an Amoeba touches some object it may move away from the source of stimulus. Jennings has found that when touched the animal does not usually move directly away from the side stimulated, but merely in some other direction. If the anterior edge is touched this part stops and contracts while the current turns to one side at this point, so that the animal moves at an angle with its former direction. If the advancing edge of an Amoeba is touched it withdraws and a new pseudopodium is sent out elsewhere. Sometimes Amoebae react positively to solid bodies, they may also under various sorts of stimuli thrust out many pseudopodia at once or draw all into a compact mass. Amoeba reacts not only to mechanical but also to chemical, temperature, light and electrical stimuli. The direction of movement in negative reactions is not determined entirely by the position of the stimulating agent. Other stimuli may have already altered the character of the protoplasm, for example the moving Amoeba is temporarily differentiated, having two ends different and the sides differing from the ends. These and perhaps other internal factors have a large part in the determination of movement.

It is impossible to explain how Amoeba alters its own metabolic process. If Amoeba is capable of self stimulation then this might suggest that living substance has a psychic quality which is possessed by all protoplasm. If this is not accepted for simpler organisms it would be hard to accept it for the cells of the cerebral cortex of man and all would be referred to present or past conditions of external or internal environment.

There is no clear evidence that Amoeba has memory. The

nearest approach to a suggestion of it comes from the observations of Jennings upon an Amoeba which attempted to devour one smaller. The ingested specimen escaped its captor, the larger reversed its movements and followed the smaller and again took it in. The behavior of the larger might seem to be partly determined by its earlier experience, but this might also be explained by a purely physical stimulus of a direct character.

Any elements of psychical qualities which Amoeba might pos-

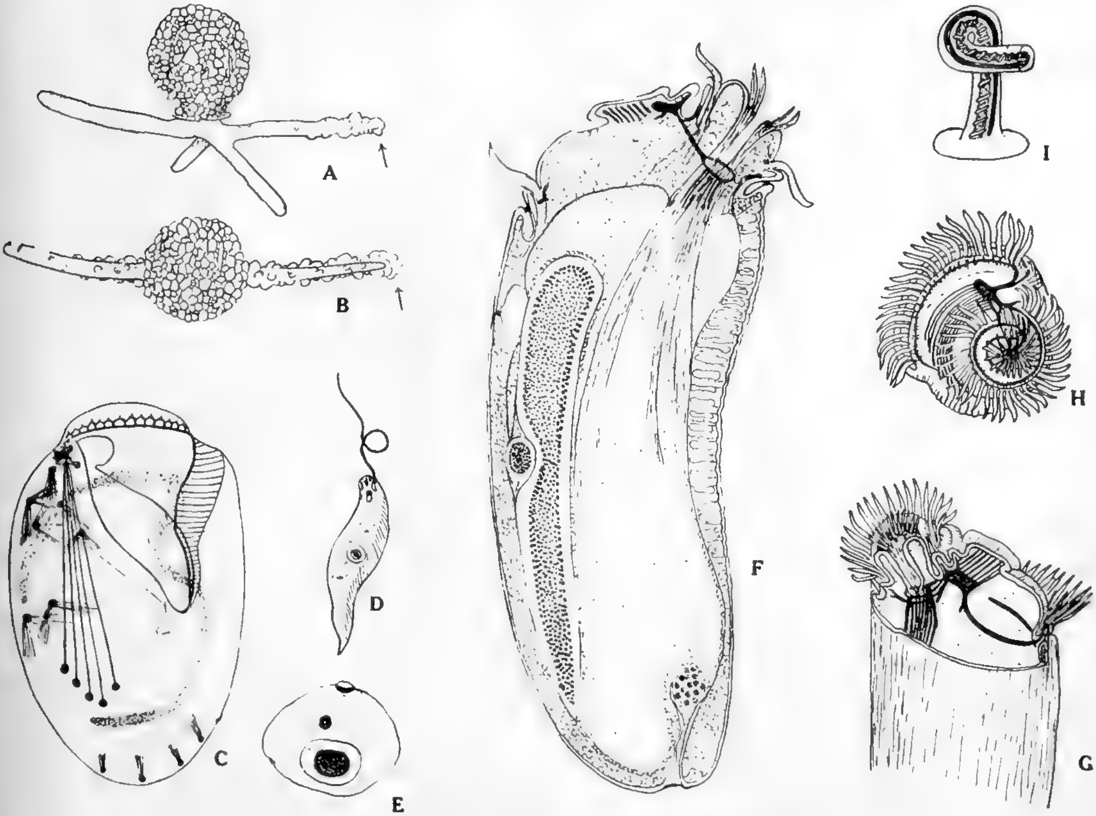


Fig. 1. Neuromotor systems and sensory systems of Protozoa. A, B. *Difflugia* showing the effects of stimulating the ends of the pseudopodia. Verworn. C. Neuromotor system of *Euplotes*, Yocum. The motorium is dark, strands to the organelles and to the cirri shown by lines. D. *Euglena* showing eye spot near gullet and flagellum. Kent. E. *Gonium* showing eye spot above. Mast. F, G and H. Neuromotor system in *Diplodinium* after Sharp. The dark lines show the location of the chief parts of the system. F. Ideal section of the whole. G and H. Views from side and mouth end. I. Stem of *Voricella* after Delage et Herouard, the contractile portion shown in dark, the conductive part in lighter.

sess are not capable of demonstration or proof. All that we can see is that if there are any elements of consciousness they must be of a very vague and elementary nature.

All forms of protoplasm have the property of irritability and there is usually also involved a certain degree of conductivity, but these are not always possible to measure or clearly determine. Verworn has made a study of conductivity in the elongated thread-like pseudopodia of some rhizopods. In studying the changes which take place in the long protoplasmic extension of *Difflugea* the results of stimulation may be directly observed. A weak stimulation at the end of the pseudopodium causes a slight wrinkling of the smooth surface, a stronger stimulus causes more swellings and more distant ones on the slender appendages. Fig. 1, A, B. The extent and rapidity of the wrinkling of the surface is in direct response to the strength of the stimulus applied. Other species of rhizopods gave similar results. The decrement of the intensity and rapidity becomes greater with the distance from the point of stimulation until the wave of excitation is obliterated. This is of course in sharp contrast to the conduction of a nerve fiber which normally conducts excitations without perceptible decrement of the intensity.

An organ for the control of amoeboid movement has been suggested, a centrosome or blepharoplast from which strands radiate to all the parts of the body which are concerned with locomotion, but no recent proof of this suggestion has come to my attention. According to Hyman the nucleus in Amoeba plays an important part in amoeboid movement, as is shown when the nucleus is removed.

Ciliate Protozoa such as *Paramoecium, Stentor, Vorticella*, etc., have much more complicated reactions than Amoeba because of their more complex structures, but the stimuli to which they respond are not much more complex or varied. The cilia are often highly specialized and localized; some coördination must be necessary. Cilia in general have been described in various ways as associated with small granules at their bases and strands from these granules have been described as penetrating into the cells, in some cases at least to be associated with a body of nuclear or cytoplasmic origin.

In 1880 Englemann found fibers in *Stylonychia* to which he assigned a nervous function. Neresheimer, 1903, found similar fibers in *Stentor*, and a number of others have described such structures without always being clear as to their function. Sharp, 1913, considers an elaborate system in *Diplodinium* which he calls a "neuro-motor apparatus.' ' From a well-marked central body or "motorium" strands of substance were found going to the cilia and to various parts of the body in a complex manner. Fig. 1, F, G, H. Yocum, 1918, describes and figures a neuromotor system in *Euplotes*, developed from the ectoplasm. Fig. 1, C. It consists of

strands running from the motorium to sensitive areas, to the membranelles and to the long anal cirri. There are also strands connected with frontal, ventral, and marginal cirri, although these are not connected with the motorium. These cirri are irregular in their movements while the anal cirri are used chiefly in locomotion. These last as mentioned, have definite connections with the motorium. Yocum traces the homology of the motorium with the blepharoplast of many forms. This is the coördinating structure which serves to regulate anterior and posterior regions

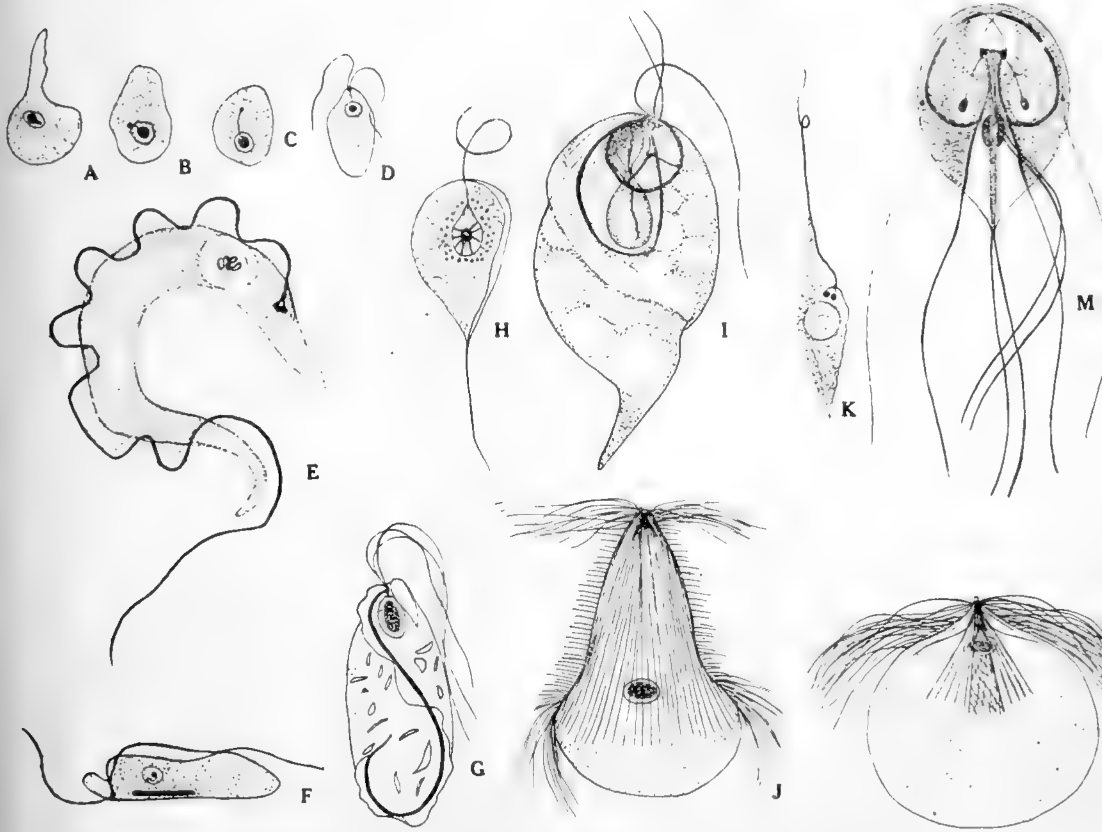


Fig. 2. NEUROMOTOR SYSTEMS OF FLAGELLATES. Nuclei and neuromotor apparatus mostly shown by dark lines or masses. A-D. Origin of blepharoplast from the nucleus in *Naegleria*. x 1040. E. Flagellate after Robertson. x 1200. F. *Trypanoplasma* after Martin. G. *Trichomitus* after Kofoid and Swezy. x 800. H. *Cercomonas* after Wenyon. I. *Chilomastix* after Kofoid and Swezy. x 3185. J. *Trichonympha* after K. and S. x 150. K. *Crithida*, after McCulloch. x 1440. L. *Leidyopsis*, Kofoid and Swezy. x 200. M. *Giardia*, Kofoid and Christianson. x 2550.

of the body. The basal granules of cilia, cirri, and membranelles are considered as secondary rather than primary structures. In ciliates the connection between neuromotor apparatus and cilia is not clearly established, but there is some indication that there may be connection.

In many flagellate protozoans the flagellum has been described as springing from a center or blepharoplast. A very primitive type of neuromotor apparatus is described by Wilson, 1916. The flagellum arises from a blepharoplast which grows out from the central karyosome (Fig. 2, A-D). The blepharoplast is connected with the karyosome by a rhizoplast.

In other forms the blepharoplast may be composed of one or more granules which may or may not be connected with the nucleus. The basal granule of the flagellum may have a double function of being a basal granule of the flagellum and also a division center for the cell. In some forms the two functions are separated in two granules. In some a number of granules surround the blepharoplast or may be derived from it. These migrate backwards and come to form the parabasal body which may in some cases be attached by a number of fibrils to the blepharoplast. This parabasal body is interpreted as an accessory kinetic reservoir. A further elaboration of this structure is the chromatic rod of some species.

Various types of flagellates with their internal connections are shown in Fig. 3. One of the most complex conditions we find in *Giardia*, Kofoid and Christianson, 1915. This is a binucleate organism equivalent to two flagellates, each containing one nucleus and one blepharoplast at the end of a single axostyle, three flagella and a half or whole axostyle, depending upon the stage of the organism. Two blepharoplasts are connected by cross commissures and are anterior. The lateral flagella cross the middle line. The blepharoplasts are joined to the nuclei by rhizoplasts and also to the parabasal body lying along the axostyle. Each organism has its own neuromotor apparatus, but due to the crossing of the fibers between the blepharoplasts the two organisms are unified. (Fig. 2, M.)

According to Yocum and others the motorium of ciliates is homologous with the blepharoplast of flagellates. According to Dobell the blepharoplast of the protozoan is homologous with the end knob and the axial filament of the metazoan sperm, whose function is to provide for the locomotoror activities of the cell. These structures are also homologous with the centrosome of resting cells.

It seems probable that other strands and coördinating centers may be found in protzoans in addition to those already described. This type of system for control or coördination is not in any sense homologous with that of Metozoa and in no sense does it lead to development of the nervous system of more complex forms. From what has already been said it is probable that methods of coördination are not at all alike in Protozoa and Metazoa; in fact it may well

be that the method in rhizopods may be of quite a different character than in the more specialized Infusoria and Mastigophora.

It is quite interesting that the neuromotor apparatus is derived from the ectoplasm. This corresponds to the probable conductive tissues in the protoplasm of plants and suggests a comparison between the origin of these parts, with the origin of the nervous system of Metazoa from the ectoderm.

Special sense organs in Protozoa are rare. In certain forms there are eye spots or masses of pigment as in *Euglena*, Fig. 1, D. and there are also eye spots or sensory areas in such forms as *Gonium*. Fig. 1, E.

LITERATURE

A few only of the more valuable or suggestive references are given.

Bovard, J. E.
1907. The Structure and Movements of Condylostoma patens. University of California Pub. Zool. 14, pp. 343-368, pl. 34. 21 text fig.

Bütschli, O.
1887-9.. Protozoa. Bronn Class u. Ordn. des Tierreichs.

Delage et Herouard
1886. Traite de Zoologie Concrete. t. i. La Cellule et Protozoaires.

Dobell, C. C.
1909. Researches on the Intestinal Protozoa of Frogs and Toads. Q. Jour. Mic. Sc. v. 53, no. 210, pp. 201-277. 1 text fig. pl. 2-5.

———
1909. Chromidia and the Binuclear Hypotheses: a review and criticism. Q. Jour. Mic. Sc., vol. 53, no. 210, pp. 279-326. 25 text figs.

Englemann, T. W.
1880. Zur Anatomie und Physiologie der Flimmerzellen. Pfluger's Arch. f. d. ges. Phys., pp. 505-35. pl. 5.

Hyman, L.
1917. Metabolic Gradients in Amoeba and their relation to the mechanism of Amoeboid Movement. Jour. Exp. Zool., vol. 24, no. 1, pp. 55-99. 14 figs.

Janicki, C.
1911. Zur Kenntnis des Parabasal apparatus bei parasitischen Flagellaten. Biol Centrbl., t. 31, pp. 321-30. 8 figs. in text.

Jennings, H. S.
1904. Contributions to the Study of the Lower Organisms. Carnegie Inst. Wash. Pub. 16, pp. 7-256.

———
1915. Behavior of the Lower Organisms. Columbia Univ. Press, pp. 1-366.

Kofoid, C. A., and Christiansen, E. B.
1915. On Binary and Multiple Fission in Giardia muris Grassi. Univ. Calif. Pub. Zool., vol. 16, pp. 30-54, pl. 5-8. 1 fig. in text.

Kofoid, C. A., and Swezy, O.
1919. Studies on the Parasites of the Termites III. On Trichonympha campanula Sp. Nov. U. Calif. Pub. Zool., vol. 20, no. 3, pp. 41-98, pl. 5-12. 4 text figs.

———
1919. Studies on the Parasites of the Termites IV. On Leidyopsis sphaerica, Gen. Nov. Sp. Nov. Univ. Calif. Pub. Zool., vol. 20, no. 4, pp. 99-116, pl. 13-14. 1 text fig.

———

1920. On the Morphology and Mitosis of Chilomastix mesnili (Wenyon). A common Flagellate of the Human intestine. Univ. Calif. Pub. Zool., vol. 20, no. 5, pp. 117-144, pl. 15-17. 2 figs. in text.

Machado, A.
1913. Sobre Ociclo evolutivo de Schizolystis spinigeri N. Sp. Mem. Osw. Cruz. t. v. fac. I, pp. 5-15, Estampas 1, 2 and 3.

Martin, C. H.
1910. Observations on Trypanosoma congeri. Part I. Divisions of the active form. Q. Jour., Mic. Sc., vol. 55, no. 219, n.s. pp. 485-496. pl. 21. 1 text fig.

Martin, C. H. and Robertson, M.
1911. Further Observations on the Caecal Parasites of Fowls with some reference to the Rectal Fauna of other Vertebrates. Q. Jour. Mic. Sc. vol. 57, no. 225, n.s., pp. 53-81, pl. 10-14.

Mast, S. O.
1916. The Process of Orientation in the Colonial Organism, Gonium pectorale and a study of the Structure and Function of the Eye Spot. Jour. Exp. Zool. vol. 20, no. 1, pp. 1-17.

Minchin, E. A.
1909. The Structure of Trypanosoma Lewisi in relation to Microscopical Technique. Q. Jour. Mic. Sc. vol. 53, pp. 755-808.

———
1911. Observations on the Trypanosomes of the Little Owl (Athene noctua), with remarks on the other Protozoan Blood-parasites. Q. Jour. Mic. Sc. vol. 57, no. 226 n.s., pp. 141-185.

McCulloch, I.
1915. An Outline of the Morphology and Life History of Crithidia leptocoridis. Sp. Nov. Univ. Calif. Pub. Zool. vol. 16, no. 1, pp. 1-22, pl. 1-4. 1 text fig.

———
1919. A Comparison of the Life Cycle of Crithidia with that of Trypanosoma in the Invertebrate Host. Univ. Calif. Pub. Zool. vol. 19, no. 4, pp. 135.

Porter, A.
1910. The Structure and Life-History of Crithidia melophagia (Flu), an Endoparasite of the Sheep-ked, Melophagus ovinus. Q. Jour. Sc. vol. 55, no. 218 n.s.

Sharp, R. G.
1914. Diplodinium ecaudatum with an Account of its Neuromotor apparatus. Univ. Calif. Pub. Zool. vol. 13, pp. 43-122. pls. 3-7. 4 figs. in text.

Swezy, O.
1916. The Kinetonucleus of Flagellates and the Binuclear theory of Hartmann. Univ. Calif. Pub. Zool. vol. 16, no. 15, pp. 185-240. 58 figs. in text.

Verworn, M.
1913. Irritability. Yale Univ. Press. pp. 1-246.

Visentini, A.
1912. On the Morphology of the Leishmania of Italian Kala-Azar. Q. Jour. Mic. Sc. vol. 58, n.s., pp. 353-370. pl. 19-20.

Wenyon, C. M.
1910. Some Observations on a Flagellate of the genus Cercomonas. Q. Jour. Mic. Sc. vol. 55 n.s., no. 218, pp. 241-250. 19 text figs .

Wilson, C. W.
1916. On the Life-history of a Soil Amoeba. Univ. Calif. Pub. Zool. vol. 16, no. 16, pp. 241-292. pl. 18-23.

Woodcock, H. M.
1906. The Haemoflagellates. Q. Jour. Mic. Sc. vol. 51 n.s., no. 197, pp. 233-331. 64 text figs.

Yocom, H. B.
1918. The Neuromotor Apparatus of Euplotes Patella. Univ. Calif. Pub. Zool. vol. 18, no. 14, pp. 337-396. pl. 14-16.

III. The Sponges

The only activities of sponges which are in any way suggestive of sense organs or a nervous system are those connected with the water currents which enter and leave.

The currents are caused by collar cells distributed in the various chambers. These flagellate cells cause the continuous movements of the liquids under ordinary conditions. The flagella of these cells are connected with basal granules or blepharoplasts in each case and in some, connections are also made with the nucleus. Fig. 3, I, J.

Lendenfeld, 1885-7, has described sensory cells and ganglion cells in sponges, Fig. 3, E, F, G, but Minchin, 1900, and others believe there are no true nervous elements. No modern work has suggested the possibility of nerve cells or sense cells in Porifera.

Parker, in 1910, describes elongated spindle-shaped cells arranged like irregular sphincters around the gastral cavity, osculum, etc. Structurally they have the appearance of a primitive

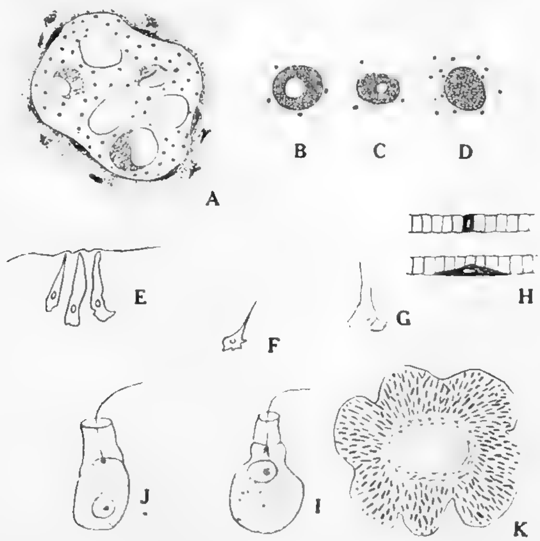


Fig. 3. Structures from sponges. A. Dermal membrane of a sponge seen from the exterior. Membrane pierced by six pores, three of which are partly closed by pore membranes. After Wilson, after Parker. B, C, D. Three stages in the closure of the membrane pore. After Wilson, after Parker. E, F, G. Sense cells and nerve cells, (?). After von Lendenfeld. H. Two stages in the development of a muscle cell as the first stage in the development of the nervous system. Diagram after Parker. I, J. Collar cells from sponges. After Robertson. x 1,000. K. Transverse section of the base of an oscular collar of a sponge showing the cavity surrounded by a sphincter of myocytes, spicules outside. Modified from Parker.

kind of smooth muscle fiber. As a result of their contraction the opening into the sponge is lessened or closed.

Wilson, 1910, describes membranes covering the subdermal cavity and containing pores. This so-called membrane is composed of an external portion and is believed to be syncytial. There are two somewhat independent devices for the closure of pores, the pore membrane and the pore canal sphincter. The closure of the pore canals is dependent upon the sphincter-like band of cells on the wall of the canal. These cells are in every way comparable to a primitive form of smooth muscle-fiber. They are in contact with the water passing into the canal and seem capable of direct stimulation. The pore membrane is less muscle like and is perhaps of a more primitive type.

Parker, 1910 and 1919, considers the sponges as an important group in illustrating the most primitive condition of the nervous system of metazoans. Muscle cells the independent effectors, as illustrated by the sphincters of sponges, were the first neuromuscular organs to appear. The special receptors in the way of sense-cells were next to appear in certain coelenterates while in other forms more complex, the adjuster or central organ was added.

LITERATURE

Bidder, G.

1896. The Collar-cells of Heterocoela. Q. Jour. Mic. Sc. n.s. vol. 38, pp. 9-43. pl. 2.

Lendenfeld, R. Von

1885. Das Nervensystem der Spongien. Zool. Ang. Bd. 8, pp. 47-50. 2 fig.

———

1887. Synocils, Sinnesorgane der Spongien. Zool. Anz. bd. 10, pp. 142-145. 2 text fig.

Minchin, E. A.

1900. Sponges. A Treatise on Zoology edited by E. R. Lankester. Part 2, chap. 3.

Parker, G. H.

1909. The Origin of the Nervous System and its Appropriation of Effectors. Pop. Sc. Mo. vol. 75, pp. 56-64.

———

1910. The Reactions of the Sponges with a Consideration of the Origin of the Nervous System. Jour. Exp. Zool. vol. 8, pp. 1-41.

———

1919. The Elementary Nervous System. Monog. Exp. Biol. pp. 1-229. 53 illus.

Robertson, M.

1911. The Division of the Collar Cells of the Calcarea Heterocoela. Q. Jour. Mic. Sc. n. s. Vol. 57, no. 226, pp. 129-139, pl. 19.

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